The FOUNDRY

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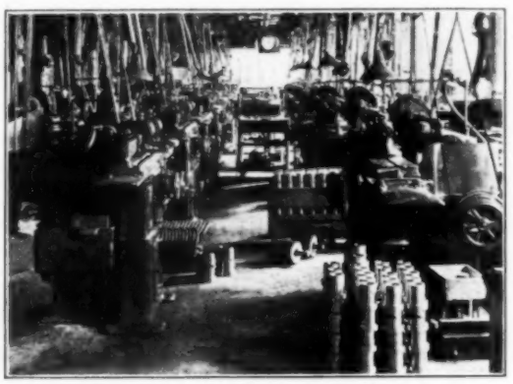
Castings Give Rigidity To Grinding Machines

DEVELOPMENT of precision grinding machines within recent years has made possible the manufacture of many present day commodities at prices well within the means of the average citizen. By far the best example of the value of the grinding machine as a production tool is found in the automobile industry. Without that type of production equipment, the low priced car probably would sell at double the



Grinding Is One of the Important Steps in the Manufacture of Automobiles

present retail price. While abrasive engineers have found their greatest field for development in the perfection of machines for use in the manufacture of automobiles, other industries have benefited greatly. Manufacturers of electrical equipment, agricultural implements, household appliances, textile machinery, machine tools and railroad equipment have found the precision grinding machine and the abrasive wheel of great value. In addition to the industries using precision machines, thousands of rough grinding machines are used in various capacities. For example, the foundry industry is a heavy user of grinders, the abrasive wheel being used in the cleaning department to remove excess metal and to improve the appearance of the casting. Since grinding machines of all kinds must be free from vibration to operate economically, castings are used extensively to provide greater rigidity.

Find Where Castings May Be Sold.

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Bronze Statue of THE

BY B. K. PRICE

Fig. 1 — Design Selected for Colossal Bronze Figure of Pioneer Woman

COURAGE, truth, constancy, affection and all the other desirable features that characterize family life, are reflected in a large bronze figure of the pioneer woman recently designed by Bryant Baker for erection in the Marland Gardens, Ponca City, Okla. The same universal sentiment that prompted Ruth to cling to Naomi, is duplicated here in the figure of a young and vigorous woman choosing to venture into a strange country with her relatives by marriage, in preference to remaining behind, alone in her native place. The agonized cry of the gentle, grief stricken and youthful widow from the land of Moab has been echoed in spirit, if not in word, by thousands of women young and old, typified in this instance by the heroic mother in the sunbonnet, with her pitiful little bundle under her arm, her Bible clutched to her breast and her small son led by the hand.

"Entreat me not to leave thee, or to return from following after thee, for whither thou goest, I will go, and where thou lodgest, I will lodge. Thy people shall be my people and thy God my God.

"Where thou diest, will I die and there I will be buried. The Lord do so to me and more also if ought but death part thee and me."

A colossal figure in bronze, 20 feet in height and rising to a point 60 feet above the base, crystallizes the sentiment of the West for the pioneer women who answered the call and regretfully gave up whatever measure of comfort they had known in large communities in the East or more sparsely settled centers in the border states, to accompany their kinsfolk through the dangers and privations, the perils known and unknown and the long lonely days and still more lonely nights in the wilderness.

They had courage and strength and energy, all the buoyant spirit of youth coupled with the maturity that goes with responsibility incident to caring for small children and to wresting a living from the soil of a virgin land. That is the kind of woman Baker had in mind when he designed the figure that finally was selected by nation wide and popular vote from a field of twelve contenders. Commencing in the Reinhardt Galleries, New York, the twelve models were exhibited for varying periods in nearly all the principal cities of the United States. Each

Local Characters

ALWAYS protected in the past by the plainsman and the cowboy, it is only fitting, right and proper that in the years to come the statue erected by Ernest W. Marland, oil magnate, Ponca City, Okla., to the memory of the pioneer or "Sunbonnet" woman will have for companions the statues of a plainsman and a cowboy. The figure of an Indian also is introduced to balance the group and to represent the third important member of a trinity typical of a past and colorful era.

To link the three additional statues more closely with the locality, three well known present day characters in the community were selected as models for the three figures—William H. McFadden, ex-foundryman, Past President of The American Foundrymen's Association, present oil man and nationally known big game hunter as the plainsman; George L. Miller, manager of the famous 101 Ranch, as the cowboy and John Bull, Ponca Indian warrior as the typical Indian.

John Bull, selected for the model of one of the three supporting statues has been declared by artists the most perfect living specimen of the North American Indian. He is a member of the first class graduated from Carlisle. He was one of the original group selected by the government of the United States in its initial experiment of giving its Indian wards a higher education. John claims kinship with the one time stormy old war chief Sitting Bull, perennial barbed and poisoned thorn in the military side of the Uncle Sam for many years and who, among other exploits, attained some measure of fame or notoriety in connection with the Custer massacre on the Little Big Horn, before going into oblivion.

PIONEER WOMAN *Immortalizes* America's Most Heroic Figure

visitor was asked to designate his choice and the total vote resulted in the acceptance of the design shown at the top of the opposite page.

According to the successful artist the pioneer woman was endowed with pride, resolution and grace. "The subject appealed to me in a special and particular manner," he is quoted as saying. "As a boy in England I read stories of the pioneers, their struggles, their hardships, their fights from behind barricaded wagons with the Indians and their struggle to make a living in a new country. Women of the early West interested me long ago. After coming here I lived for a while in the West to study and observe its spirit. When the opportunity was presented to work on this splendid memorial I was deeply moved. What other woman ever had a better claim to glory? Her figure to America should be what the *Victory of Samothrace* was to Greek life and art. The ideal is combined in a beautiful way with hardy resistance. The pioneer man blazed the trail and provided the food and raiment, but the woman built and kept the home fire burning and stirred the pot until the contents were fit for human consumption. In the wilderness she had to fill the quadruple role of home maker, companion, sweetheart and mother.

"I can see her as a mother, bending eyes of love and maternal pride on her son. He is to be the man of tomorrow who will realize some time, some of the dreams she dreamed before she went adventuring. She holds him by the hand to lead and protect him. She is young but she has known what it is to struggle and overcome trials mental and physical. You can see it in her poise, in the free swing of the limbs, in the steadfast eyes gazing from under serene, and level brows toward the far away horizon. She is going forward ready to meet, and competent to handle any situation with which she may be confronted. These are some of the things I have thought about the pioneer woman and which I have tried to incorporate in the model."

Fig. 2—The Plainsman, One of the Three Supporting Figures in the Pioneer Woman Group

Without exception the various designers agreed that the figure should be typical of the early American woman, also that a vigorous mother is more nearly typical of the spirit of the old frontier days than the withered woman sometimes presented as indicative of that period. This period more than any other is distinctively American. The winning of the West represented an outpouring of sentiment, adventure, necessity, lure of the unknown and a dozen other emotions. A great deal is heard in the present age about the freedom of women and their enterprise. How does this freedom and enterprise compare with that of the frontier mother who reared a family by the camp fire, without a single one of the features that in the present age are regarded as absolute necessities. The frontier woman could and did, hoe a patch in the wilderness, drive a team of horses, wield an ax, handle her

husband's flintlock musket and do a man's share in resisting attacks of Indians or any other form of menace.

The basic idea of erecting a permanent monument to the early women of the West was conceived by Ernest W. Marland, head of the Marland Oil Co., Ponca City, Okla., a native of Pennsylvania, but a resident of the oil country for the past 20 years. In a statement given out shortly after the idea began to take tangible shape he is quoted as saying: "I don't know much about art, but I have noticed that ever since the beginning of civilization all nations have honored their greatest citizens by sculptured representation. Who is more deserving of a statue than the pioneer woman? I determined she should have her statue, the best likeness and interpretation we of today could create. Also it will stand in a place she herself might have chosen."

The second step in the process was to invite sculptors to submit opinions, drawings and models of what they considered suitable monuments. A process of elimination by popular vote decided which design to accept. With all this preliminary work disposed of satisfactorily the sculptor was free to construct his full size figures and to actually commence work in the foundry where the figures were to be reproduced in everlasting bronze. The castings were made at the plant of the Roman Bronze Works, Inc., Greenpoint, Brooklyn, N. Y., where work of this character has been carried on successfully for many years.

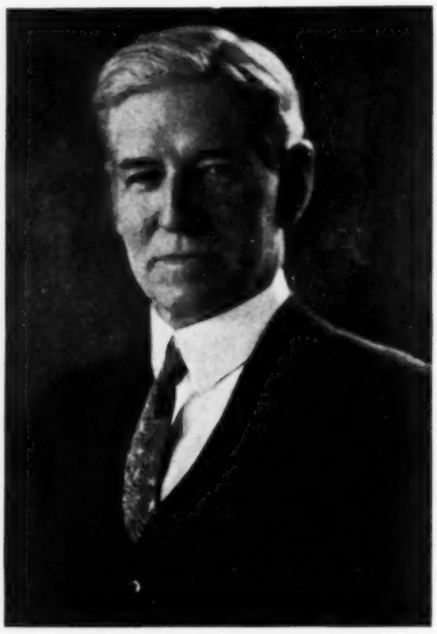
If necessary, figures up to 10 feet in height and even larger may be cast as units in this foundry, but usually it is more expedient to cast large figures in sections. The term heroic is applied to figures of men or women 9 or 10 feet in height. Representation of the human figure over 10 feet in height is referred to as colossal and this classification includes the pioneer woman under consideration. The figure is to be approximately 20 feet in height. The sculptor and foundryman mutually determine upon the number of sections into which it is advisable to cut the figure and suitable joints, known as *Roman* joints are provided on adjoining edges of these various sections. Later when the sections are joined and the complete figure is erected in place these joints are hammered over and then the surface is smoothed so that no trace of a joint remains. From a manufacturing viewpoint it is rather interesting to note that this form of joint was developed by the Romans, as the name indicates, for this specific purpose and the idea has defied improvement down to the present.

Two principal methods are employed in the foundry for molding castings of this character. One is known as the piece mold method in which the mold is made in many sections, taken apart for removal of the pattern, reassembled again and poured. The thickness of metal is secured by shaving a corresponding thickness of sand from certain sections of the mold, usually the core. A special sand imported from France is used for making the mold and core.

The second method known as the *cire perdu* or lost wax method is practised extensively at the plant of the Roman Bronze Works, Inc., and that was the method employed in casting the various parts for the figure of the pioneer woman and the three supporting figures, the plainsman, the cowboy and the Indian. In this method a wax duplicate of the casting is enclosed in a mass of plastic refractory material. The entire assemblage is placed in an oven and raised to a high temperature. The wax melts and runs out through suitable openings in the lower part of the mold. The mold then is placed in a pit or suitable flask where sand is rammed around it for reinforcement. Metal is introduced through a number of vine like gates attached to many strategic points and all fed from a basin on the top.

Detail of preparing the pattern differs to a certain extent depending on which molding method is to be employed, also on whether more than one casting is to be made. With the *cire perdu* method and where only one casting is required the method of op-

Played Prominent Part in the Foundry



WILLIAM H. McFADDEN at the age of 15 began his industrial career in 1888 with Mackintosh Hemphill & Co. Ltd., Pittsburgh. He entered as a special apprentice and had experience in every department where, by working day and night, Sundays included, he crowded the equivalent of four and a half years into the three-year apprenticeship term. His progress and grasp of the business was so remarkable that before his term expired he was sent by the company to superintend the construction of the Ashland Steel Co. plant at Ashland, Ky. In 1893 he was appointed foreman of the open-hearth steel department of Mackintosh Hemphill & Co., and the following year was appointed superintendent. He was made assistant manager of the company in 1896 and vice president and general manager in 1902. Broken health caused his resignation in 1910 and his removal to Oklahoma, where he staged a remarkable comeback and entered the oil industry. Since 1920 he has served as senior vice president of the Marland Oil Co., and was mayor of Ponca City, Okla., from 1914 to 1920. Mr. McFadden served as president of the Pittsburgh Manufacturers association and the Pittsburgh Foundrymen's association in 1905; the American Foundrymen's association in 1906; vice president Steel Founders Society of America, 1909-10; vice president General Steel Casting association, United States and Canada, 1903-1910, and was actively associated with the National Founders' association for many years as chairman of the Third district.

eration is as follows: The full size plaster pattern is painted with shellac and then covered with a layer of clay corresponding in thickness to the desired gelatin mold. In some instances the clay may be applied all at once over the pattern. In others it is applied to one section at a time and that part of the job is finished before attempting the remainder. A thick layer of plaster is applied to the clay and is divided into two or more parts so that it may be removed when it has dried and solidified. The plaster jacket is lifted away from the pattern and the clay is removed. The face of the jacket is washed clean and then it is shellacked to render it liquid proof. The jacket is returned to place over the pattern and the space between, formerly occupied by the clay, is filled with gelatin in a fluid condition, poured in through suitable openings.

After the gelatin has solidified it is removed from the pattern. The inside then is painted with beeswax. A camel's hair brush is employed and care is taken to apply the material with the greatest exactness. In small molds the interior is filled with a molten mixture of rosin, beeswax and ceresin. The proportions vary to some extent depending on local conditions including the temperature of the atmosphere, but usually the proportion of ceresin and beeswax is 30 and 70 per cent respectively. Some molds are rolled and others are allowed to remain quiet until the wax mixture has congealed to the desired

Fig. 4 (Left)—Plaster Mold for The Plainsman, Minus the Head, Partly Completed. Fig. 5 (Above) —Where Some of the Molds Are Made at the Plant of the Roman Bronze Works Inc.

Fig. 3 (Below) At the Back Center a Group of Men Are Shown Ramming Sand Around a Mold in One of the Casting Pits

thickness against the gelatin mold. Then the remainder of the mixture is spilled out, leaving a wax shell conforming to the outer shape of the original pattern and of a thickness equal to the thickness of the proposed casting.

Temperature of the molten wax must be determined carefully. If it is too hot it will melt the thin coating applied with the brush and will affect the gelatin mold. If it is too cold it will not flow properly. In some instances where conditions are favorable sheets of wax are applied by hand and pressed into place.

The wax figure then is filled in with a core. At one time brick dust and plaster generally were used, but on account of the difficulty of securing brick dust of the proper quality, straight silica now is used instead. After the core has set properly the gelatin mold is removed without any difficulty. It is pliable like rubber and may be stretched to some extent where necessary. The wax figure with the core inside then is examined by the sculptor and receives his final O. K. before it is covered by the outside part of the mold.

The process then is continued by first applying gates and vents in the shape of wax rods ranging in size from ¼ to 1 inch in diameter according to the size of the casting. Of course, the gates are attached to the figure in suitable manner to distribute the metal rapidly and uniformly

to all parts of the mold. The vents are located at the high points where the air escapes as the metal fills the mold.

First, the core must be secured so that it will retain its proper position with relation to the outside of the mold at two important periods: After the wax support has been melted away, and while the molten metal is exerting heavy pressure while filling the space between the core and the mold. This is done by drilling a number of holes through the wax in unimportant places and into the core and then inserting pieces of bronze rod to serve as chaplets. The entire wax figure then is covered with the silica mixture and additional gates and vents are placed in the desired positions to distribute the metal uniformly. A much heavier coating then is applied as shown in Fig. 4 with the headless figure of the pioneer man in the foreground. The final layer of silica is smoothed to present an approximately uniform surface and the assembly is allowed to set for several days until thoroughly air dried.

Is Baked Slowly

The entire unit then is lifted by a crane and placed in one of several knockdown kilns or ovens, which are built each time to a size adequate to enclosing any particular mold. The unit is allowed to bake over a slow fire for several days and until all the wax has melted and run out. Coal or coke is employed to dry the large molds. Small molds are dried over night with gas.

After the mold has cooled it is taken to the pouring floor where it is lowered into a pit and sand is rammed around it to afford the necessary resistance when the mold is filled with molten metal. The metal mixture is made up of 90 per cent copper, 7 per cent tin and 3 per cent zinc and is melted in a battery of crucible furnaces fired with coke and coal. A basin is constructed on top of the mold with capacity for all the metal required to pour the casting. After it is filled the plug or plugs are removed from the bottom and the metal flows through all the small branch gates and into the mold.

After the casting has cooled it is removed from the mold and taken to the cleaning room where the gates are chipped off. It then is given a bath in a solution of nitric and sulphuric acid and afterward scrubbed with a stiff brush. Usually only a little finishing is required and that is done by highly skilled workmen. Application of the patina or coloring, constitutes the final step and is accomplished by the action of acid and heat. The resulting color may be brown or green or any of the shades between at the discretion of the artist.

Book Review

The Modern Gasoline Automobile, by Victor W. Page—11th edition—1928—1148 pages, 6 x 9 inches, flexible binding. Published by the Norman W. Henley Publishing Co., 2 West Forty-fifth street, New York. Available through THE FOUNDRY, Cleveland, for $5, and from the Penton Publishing Co., 416-17 Caxton House, Westminster, London, for 25s.

The modern motor vehicle has proved itself to be such a reliable and economical method of transportation and its worth has been so conclusively demonstrated that it is now indispensable in modern life. The 60 makers or firms, which produce about 100 chassis models, manufactured upward of 4,000,000 automobiles in 1927.

This work deals with the various types of modern motor vehicles as to the body, engine and transmission construction comparing them with those of the more ancient models. Modern engines and their operating principles are discussed at great length with descriptions of the construction and functions of the various parts. The many classes of fuels are discussed with the working principles of the different makes of carburetors now on the market. Ignition, lubrication and cooling systems are described. The latter part of the book deals with the transmission systems and chassis construction. Clutches, axle construction, change-speed gearing, drive methods, brake systems and starting and lighting systems are explained. The last few chapters deal with the running and care of automobiles, and the methods used to locate the various troubles in the different parts of the machine. The last chapter of the book explains the features of the new Ford Model A cars.

The author of this book goes to great lengths in explaining the functions and construction of the various parts of the modern automobile. His discussions are well illustrated and detailed. The book contains over a thousand illustrations.

Family of Artists

BRYANT BAKER, designer of the Pioneer Woman group of statuary, was born in London, Eng., a descendant of a long line of sculptors. With his father and his grandfather he has worked on the decorative carving in Westminster Abbey. A brother also is a well known sculptor. Mr. Baker has lived in the United States for more than 14 years and during the war he served as sergeant, first class medical corps in the American Expeditionary Force. He has executed busts and statues of four recent presidents, Coolidge, Wilson, Taft and Roosevelt. Herbert Hoover, Gen. Pershing and Chief Justice White have been included in his list of sitters. In England his statue of the late King Edward VII at Huddersfield was unveiled by George V at the special request of the late Queen Alexandria.

Publishes Supplement

Recently the American Society for Testing Materials published a 195-page supplement containing 41 standards adopted or revised by letter ballot of the society on Sept. 1, 1928. This is the first addition to the 1927 Book of Standards published by the society. In this supplement 13 standards relate to metals and the remainder relate to nonmetallic materials. Foundrymen will be interested in the standards for aluminum bronze castings; sand castings of the alloy, 88-8-4; steam or valve bronze sand castings; composition brass or ounce metal sand castings; yellow brass sand castings for general purposes; bronze castings in the rough for locomotive wearing parts.

Desires Information

J. B. Deisher, representing the malleable foundry members of the American Foundrymen's association on the committee on ferrous metals advisory to the bureau of standards has announced that he requests suggestions on research problems from members of the association. Such information from the members will aid the committee in serving the industry. Communications should be addressed either to J. B. Deisher, 24 Roslyn street, Rochester, N. Y., or to the chairman of the American Foundrymen's association committee on malleable castings, care of executive secretary's office, 222 West Adams street, Chicago.

The International Oxygen Co., Newark, N. J. has taken over the business of the Tariffville Oxygen & Chemical Co., Tariffville, Conn., and will operate it as the New England division, International Oxygen Co.

Presents Theories On Graphitization-I

By H. A. Schwartz

KNOWLEDGE of the laws governing the liberation of carbon from its compounds with iron is of fundamental importance to all iron foundrymen. The manufacturer of gray cast iron is interested in the formation of graphite during freezing and cooling in the mold. The malleable foundrymen wish to suppress such graphitization and promote the formation of graphite during the subsequent heat treatment. According to American nomenclature, the formation of free carbon during freezing is called *primary* graphitization and that during a subsequent heat treatment *secondary* graphitization.

Primary and secondary graphite are identical, chemically and crystallographically, but differ in exterior form. Primary graphite growing in a liquid or at most viscous medium, at high temperatures forms idiomorphic crystals, i. e., crystals whose outer form is determined by their habit of crystallization, whereas secondary graphite, or temper carbon, forms allotriomorphic crystals, i. e., crystals whose outer form is imposed upon them by external conditions: here the constraint of the surrounding solid, though plastic, metal.

Will Be a Guide

Obviously, a single system of laws must cover the whole subject, although the author proposes to consider particularly the conditions of secondary graphitization with but occasional reference, where necessary, to primary crystallization of graphite.

Unfortunately, we are as yet far from being able to explain consistently all the phenomena of graphitization or to describe in detail its mechanism. Nevertheless, a scrutiny of what we do, or do not know, will perhaps be of interest and value as a guide to new research and to sound industrial practice.

The physical chemist thinks of graphitization in terms of the reaction

$$Fe_3C = 3\ Fe + C$$

and says that the reaction is reversible, and under any given conditions, proceeds in whatever direction corresponds to the liberation of energy. Thermodynamically, this simple expression suffices since the second law does not need to concern itself with the intervening steps by which we go from the initial to the final condition.

Metallurgically, the matter is more complicated. Many observers, Bolton, *Transactions*, American Foundrymen's association, Vol. XXXII, Part 1, believe that especially in the case of nonhypoeutectic alloys cementite is actually graphitized *in situ*. In the case of secondary graphitization one need only glance at micrographs of white cast iron and the resulting malleable, as shown in Figs. 1 and 2, to realize that the temper carbon of the latter is not arranged like the cementite of the former and hence that graphitization has not taken place *in situ*.

Do Not Agree

At least in the case of secondary graphitization the reaction involves the following steps: solution of Fe_3C, migration of the carbon in some form through the solution and crystallization of carbon from the solution. Also, since the carbon was originally present as a chemical compound and finally remains as the element, at some stage the chemical compound must have decomposed.

Jeffries and Archer, *The Science of Metals*, believe that large molecules of Fe_3C cannot migrate through the gamma iron space lattice since they are obviously much larger than the atomic spacings, but Fry, *Stahl und Eisen*, 1923, has demonstrated that phosphorus can migrate both as the element and as the phosphide. The author, therefore, does not regard the reasoning of the former as necessarily conclusive evidence as to the form in which carbon exists in solid solution.

In metallic solid solutions it is usually the case that the atoms of solute substitute for solvent atoms retaining the space lattice of the latter. It has been shown, however, by Westgren and Phragmen, *Journal*, Iron and Steel institute, Vol. CIX, No. 1, 1924, that in austenite, the solution in equilibrium with cementite, the carbon atom is in the center of a

Writes Exchange Paper

THIS is the first of two articles abstracted from a paper written by the author which will be presented in behalf of the American Foundrymen's association at the annual meeting of the Association Technique de Fonderie de France which was held at Paris, France, Oct. 26 and 27.

H. A. Schwartz, the author, was born in Oldham county, Ky., in 1880 and was graduated from Rose Polytechnic institute, Terre Haute, Ind., in 1901 with the degree of bachelor of science. In 1903 he received the degree of master of science and the degree of mechanical engineer in 1905. From 1902 to 1920 Mr. Schwartz was employed at the Indianapolis works of the National Malleable & Steel Castings Co., as draftsman, chemist, metallurgist and assistant superintendent. Since 1920 he has been manager of research at the Cleveland plant of the National company. He is a member of the American Society for Steel Treating, American Institute of Mining and Metallurgical Engineers, American Foundrymen's association, American Society for Testing Materials, Society of Automotive Engineers and the Iron & Steel institute (London). Mr. Schwartz is the author of American Malleable Cast Iron, and numerous technical papers. He also is a special lecturer at the Case School of Applied Science, Cleveland.

H. A. Schwartz

face centered cell of gamma iron.

The author *Transactions*, American Institute of Mining and Metallurgical Engineers, Vol. LXVIII, 1923, has published data showing there are two solutions of carbon in iron differing in kind, and has substantiated the contention by showing that the solutions differ, not only in maximum concentration but also in electrical resistivity and other properties. For the solid solution in equilibrium with carbon he has proposed the name *boydenite* commemorating the inventor of the *black heart* malleablizing process.

He has also pointed out, *Transactions*, American Society for Steel Treating, 1927, Vol. XI, that in boydenite the carbon atom perhaps may occupy the position normally occupied by an iron atom in the gamma lattice.

It is perhaps questionable whether a carbon atom in the center of a face centered cube of iron atoms and hence nearer to the six atoms in the face centered positions than to the eight at the corners and further dominating one-half of each of these six atoms can be considered to be combined as Fe_3C. The essential point now to be observed is that the carbon atom not only migrates over relatively large distances, as compared with the atomic spacing but also at some stage of the graphitizing reaction moves from the central, additive position which it occupies in the gamma lattice when in equilibrium with Fe_3C to a substitutional position when in equilibrium with carbon.

It may be of interest to say at this point that carbon obtained from cementite in white cast iron by solution in copper ammonium chloride did not give an interference pattern when investigated in the X-ray spectrometer by E. C. Bain, according to a personal communication to the author.

It is thus evident that the atoms in the carbon so obtained are not held together crystallographically in any regular order to any large extent, although aggregations a few atom layers thick might escape detection. The observation, at any rate, raises a presumption that the carbon atoms of cementite, if joined at all to other atoms, are joined only to those of iron.

Schenck, *Zeitschrift fur anorganische und allgemeine Chemie*, Vol. 167, 3-4, seems to have found that the gas phase in equilibrium with alloys in which cementite partly was graphitized, was that corresponding to equilibrium with carbon. This suggests the probability that the carbon which migrates is in substitutional positions, as it would be when in equilibrium with carbon. We are thus led back to the Jeffries concept as applying in the stable system.

A point which is still far from clear is that if a carbon atom migrates from the center of one cell to that of the next it is at some moment in the surface of that cell and then indistinguishable from an atom moving from the center of one face to the center of an adjacent face situated in the same plane. Are we to overcome this difficulty by the assumption that migration of an atom is not a continuous progress but a series of quick jumps between certain fixed positions coupled with relatively long intervals of rest in these positions? If so, then migratory rate is a misnomer and actually means not the rapidity of the atom's motion but the frequency with which it moves at all. Such speculations, however, are at best merely interesting and far beyond our experimental knowledge.

Graphitization involving the successive steps, solution of Fe_3C in iron, migration of carbon, change of position of carbon in the space lattice (of gamma iron) and crystallization of carbon, has its rate determined by the slowest of these steps.

The author, *Transactions*, American Society for Steel Treating, 1926, Vol. 9, has shown that in the early stages, i. e., until about one-half of all the carbon available for graphitization at a given temperature is deposited in the free state, the amount of graphite deposited in an ordinary white cast iron increases as the one and one-half power of the time, and that when the process approaches completion the logarithm of the carbon remaining available for graphitization decreases uniformly with time. It was shown in the reference that these observations, as well as others regarding the transition from the one relation to the other and the points of inflection in the graphite temperature curve are consistent with the assumption that migratory rate is the determining factor in fixing graphitizing rate.

It was also shown that the thermal coefficient of graphitizing rate, i. e., the ratio of the graphitizing rate at two different temperatures quantitatively is similar to the thermal coefficient of the rate of diffusion of carbon in gamma iron. These data are confirmed by those of Gladhill presented in an exchange paper before the American Foundrymen's association in 1921.

So far as we know the purest available Fe_3C is metastable. The facts have been recorded by many observers and most recently by Maxwell and Hayes, *Journal*, American Chemical Society, Vol. 48, 1926. In the pure binary system, however, the reaction is usually slow, sometimes to such a degree that graphitization actu-

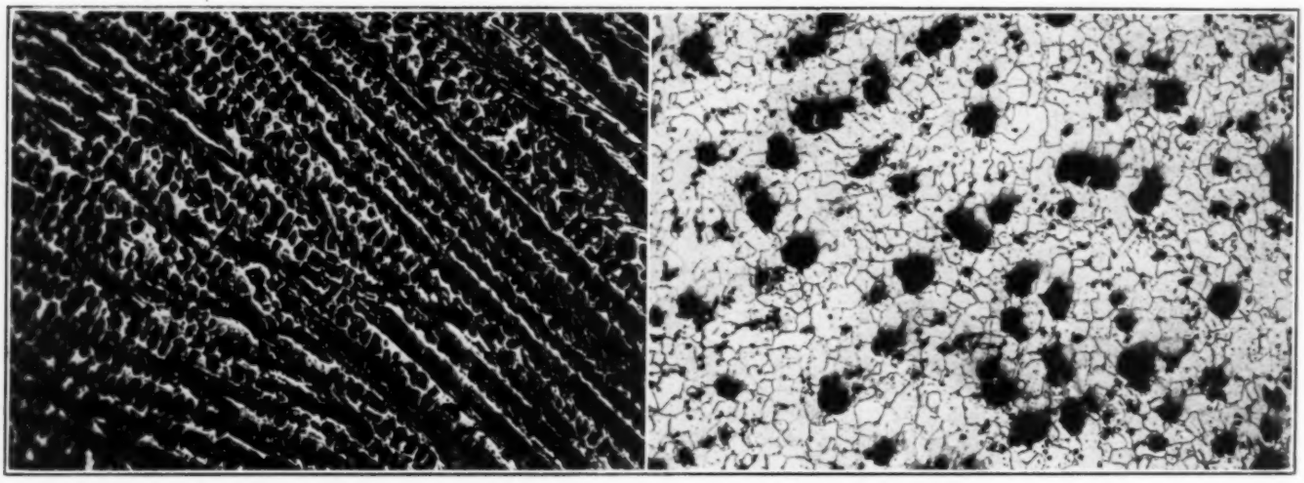


FIG. 1—MICROGRAPH OF WHITE CAST IRON SHOWING THE ARR ANGEMENT OF CEMENTITE. FIG. 2—AFTER HEAT TREATMENT THE CEMENTITE IS TRANSFORMED INTO TEMPER CARBON WITHOUT RELATION TO THE PREVIOUS ARRANGEMENT OF CEMENTITE. BOTH MICROGRAPHS ARE FROM THE SAME SPECIMEN

ally seems impossible. This is more particularly true, even in the presence of other elements, for low carbon concentrations.

The effect of other elements on graphitization was studied by Kikuta, *Science Reports*, Tohoku Imperial university, Vol. XV, No. 1, 1926, and by Sawamura, *Memoirs*, college of engineering, Kyoto Imperial university, Vol. IV, No. 4, 1926. Both these observers studied the progress of the reaction by the use of the dilatometer in the manner developed in France by Portevin and Chevenard, *Transactions*, American Foundrymen's association, Vol. XXXIV, 1926.

Investigate Effect of Elements

Kikuta observed the time to attain maximum dilation at constant temperature in the presence of various concentrations of a relatively limited number of elements and so determined whether they accelerated or retarded annealing. Sawamura investigated many more elements but contented himself without quantitative data as to the time to reach equilibrium. He recorded mainly the temperature at which for a constant heating rate the expansion due to graphitization began and reached a maximum rate in the experiment he performed.

The author's experiments always have, when quantitative, been conducted by chemical determinations of the graphite found in specimens quenched after known times at known temperatures. The method is more time and material consuming than the dilatometer but was adopted before that instrument was in common laboratory use.

This procedure also has advantages under some environmental conditions which would interfere with dilatometer observations, and permits of observing the results on many specimens which have actually been heat treated together. It is quite likely that if he had begun his researches after the dilatometric method was evolved, he would have adopted that form of experimentation.

Qualitative data obtained when irons containing a foreign element and without it, are annealed together also shed light upon the subject. The author's associates have studied the effect of substantially all the elements which are obtainable by purchase giving the greatest emphasis to those likely to occur in commercial iron alloys.

The elements found favorable to graphitization were silicon, aluminum, nickel, titanium, zirconium and uranium. The elements which distinctly hinder graphitization, Schwartz and Guiler, *Transactions*, American Foundrymen's association, Vol. XXXIII, are chromium, manganese, sulphur, selenium, tellurium and antimony. Tin in sulphur-bearing irons also interferes and cerium and the rare earths may interfere or help depending upon the amounts of other elements, especially manganese and sulphur present. Boron may help or hinder, depending upon its concentration. Molybdenum and possibly vanadium, may interfere if present in high concentration. Copper, cobalt and gold are believed by some to favor graphitization. Phosphorus is regarded as favoring graphitization but as increasing the effect of sulphur.

The following elements such as lead, silver, antimony thorium, glucinum, cadmium, zinc, mercury, the alkalies, the alkali earths and probably the halogens are not found in iron, although Lunder and Fellenberg, *Zeitschrift fur anorganische und allgemeine Chemie*, Vol. 165, have observed the existence of iodine in metal in small amounts (generally under 1 milligram per kilogram). The elements tantalum, platinum, columbium, palladium, gallium and tungsten almost certainly are without measurable effect.

The effect of oxygen is somewhat peculiar, Honda and Murakima, *Journal*, Iron and Steel institute, Vol. CII, No. 2, 1920, find that iron contaminated by oxygen graphitizes with increasing readiness. Hayes and Scott, *Transactions*, American Foundrymen's association, Vol. XXXIII, showed graphitization to be accelerated in the presence of an atmosphere of CO-CO_2 under increased pressure.

Prepare Cementite From Oxide

Yet all the available evidence, for example, Matsubara by a study of gas equilibrium, *Transactions*, American Institute of Mining and Metallurgical Engineers, Vol. LXVII, 1922, as well as many papers by Schenck, show that cementite is more easily prepared from iron oxide than from iron and that Fe_3C in an oxide bearing metal is stable toward carbon and hence obviously, stable toward pure Fe_3C. It is possible that we have here two quite distinct actions of oxygen. When present in the gas phase it perhaps furnishes a medium for increasing the migratory rate of carbon by diffusion as CO and CO_2, while when present in solid solution it alters the equilibria of the iron-carbon system in such a manner as to increase the stability of cementite.

Since oxygen, Schenck and Dingmann, *Zeitschrift fur anorganische und allgemeine Chemie*, Vol. 166, is in solid solution as oxo-ferrite, capable of giving up its oxygen to the gas phase, there is here a possibility that oxygen may first stabilize Fe_3C then combine to CO-CO_2 and by its removal from the solid phase, cause Fe_3C to become metastable and by its presence in the gas accelerate the attainment of stable equilibrium. It is rather doubtful whether hydrogen and nitrogen could survive the graphitizating heat treatment.

It seems an obvious step to attempt to explain the effect of the several elements on graphitization by their effects upon the rate of migration of carbon in iron. These rates have, in a number of cases, been measured by Tammann and Schonert, *Zeitschrift fur anorganische und allgemeine Chemie*, Vol. 122, but no relation can be found showing that the elements generally affect migratory rates and graphitizing in the same manner. Instances do exist, especially where nonmetals form compounds with metals in the form of thin films as observed by Levy, *Carnegie Scholarship Memoirs*, Iron and Steel institute, Vol. III, in the case of sulphur and inhibit graphitization by stopping migration. The change in the effect of boron from positive to negative occurs at the point where films of iron boride begin to form.

Determine Solubilities

The potential for the migration of carbon is furnished by the differences in its solubility from cementite and carbon. These solubilities are given by the A_{cm} and A_{ar} lines of the usual *double* iron carbon diagram as developed by Benedicks and others. These lines extend from the eutectoid points to the end of eutectic lines of the diagram.

Obviously, an element which itself does not affect the migratory rate of carbon in solid solution, if its presence increases the difference in carbon solubility in the stable and metastable system, might increase the rate at which carbon travels by increasing the concentration gradient between those portions of the solid solution saturated with Fe_3C and C respectively.

The author, *Transactions*, American Institute of Mining and Metallurgical Engineers, Vol. LXIX, 1923, and Hayes and Wakefield, *Transactions*, American Society for Steel Treating, Vol. X, No. 2 believe that silicon does increase the *difference* in *solubility* in the two systems and hence the rate of carbon migration.

The effect of various alloying elements on the stable iron-carbon diagram is not yet sufficiently known to permit us to test the general applicability of this rule.

Institute of Metals Meets With Steel Treating Group

Metals Division of the American Institute of Mining and Metallurgical Engineers Holds Sessions In Philadelphia—Plan International Conference

THREE technical sessions and 13 papers featured the program of the institute of metals division, American Institute of Mining and Metallurgical Engineers at the annual fall meeting in Philadelphia held coincident with the convention and exposition of the American Society for Steel Treating and the regular fall meeting of the American Welding society.

Headquarters for the institute of metals division were maintained at the Benjamin Franklin hotel, where registration reached approximately 200. The first technical session on Tuesday morning was devoted chiefly to nonferrous metals. O. W. Ellis, metallurgical engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh, presented a paper on the absorbability of gases in copper. Among other conclusions he finds that the volume of gas occluded by solid copper is a function of melting conditions and that the oxidation of copper in electric furnace melting practice may be prevented by addition of small amounts of carbon, 1½ pounds of charcoal to a 150 pound charge, having been found effective.

Mr. Ellis states that he found a definite relation between carbon dioxide and carbon monoxide in solid copper. In discussing this point S. L. Hoyt, research laboratory, General Electric Co., said that he was surprised at this, as he understood that carbon dioxide broke down at high temperatures. Mr. Ellis replied that he also was surprised but that the results had been carefully checked and apparently the presence of the copper assisted some way in maintaining the integrity of the carbon dioxide.

T. S. Fuller, research laboratory, General Electric Co., Schenectady, N. Y., presented a paper describing the use of rare elements in the electrical industry. Argon, helium and neon are used in incandescent lamps, with an annual saving to the public of about $400,000,000, compared with the method of illumination without the use of these elements. Tungsten affords an even greater saving. It would cost the public about $2,000,000,000 more annually if it used the same amount of artificial light as now, but used the old carbon filaments instead of tungsten filaments.

An interesting and well illustrated paper on the copper-silicon system was presented by Cyril Stanley Smith, research laboratory, American Brass Co., Waterbury, Conn. The feature of this paper is the development of a new equilibrium diagram of copper-silicon alloys, regarded by later speakers at the session as an important contribution to the knowledge of metallurgy.

Results of extensive experiments in the field of diffusion of zinc into copper were presented by S. L. Hoyt. These data, according to Dr. Zay Jeffries, consultant metallurgist, Cleveland, who discussed the paper, is the best contribution of a quantitative nature so far offered on the zinc-carbon group.

Wednesday afternoon, the institute of metals division held a short session with the American Society for Steel Treating in the assembly room of the commercial museum. Dr. Jeffries presided and five papers on structure of steels and steel alloys were read and discussed. Francis F. Lucas, Bell Telephone laboratories, New York, presented a paper on the microstructure of martensite. This was illustrated by slides showing microphotographs of 3500 diameters. It is a painstaking, scientific presentation of the author's further study of martensite as he presented a paper on the same subject in Boston in 1924. The discussion of this paper was led by Dr. Albert Sauveur, professor of metallurgy, Harvard university, Cambridge, Mass.

The microstructural effect of cold working high manganese steels is described in a well illustrated paper by V. N. Krivobok, associate professor of metallurgy, Carnegie Institute of Technology, Pittsburgh. The treatment and structure of magnesium alloys was discussed at length in an illustrated paper by John A. Gann, metallurgist, Dow Chemical Co., Midland, Mich.

The supposition that Neumann bands in ferrite are twins has been definitely settled in the affirmative. A highly technical paper on this subject was presented by C. H. Mathewson and G. H. Edmunds, and was read by Professor Mathewson who heads the metallurgical department at Yale university, New Haven, Conn. Mr. Edmunds is graduate student in his department. The study of this subject was made with the assistance of X-ray reflections from crystal surfaces.

At the Thursday morning session, the paper on cold rolling and heat treatment of britannia metal by B. Egeberg and H. B. Smith was read by Sam Tour, metallurgist, Doehler Die-Casting Co., Batavia, N. Y., in the absence of the authors. Both authors are metallurgists of the International Silver Co., Meriden, Conn.

(*Concluded on Page* 901)

International Meeting Planned for 1932

THE British Institute of Metals has accepted an invitation to meet with the institute of metals division of the American Institute of Mining & Metallurgical Engineers in the fall of 1932. *Announcement of this acceptance was made by W. M. Corse, secretary, institute of metals division at the annual dinner which was held at the Benjamin Franklin hotel Wednesday evening.*

Dr. W. H. Hatfield, metallurgist, Brown-Firth Research laboratories, who was guest at the dinner, was asked to carry back to England an expression of the pleasure with which the American institute members looked forward to the 1932 *joint meeting.*

George Otis Smith, president, American Institute of Mining & Metallurgical Engineers, told of the work of that organization and of the increasing importance of the institute of metals division. S. Skowronski, Baltimore Smelting & Refining Co., Baltimore, and chairman of the institute, presided, and Dr. F. M. Becket, vice president, Union Carbide Co., New York, gave the principal address which was an elaborate historical account of the development and use of chromium alloys.

Aircraft Casting Alloys *Must Possess* Stability and Permanence

By A. J. Lyon

SPONTANEOUS hardening, or age-hardening, which takes place in some of the aluminum alloys under ordinary conditions of temperature and atmosphere, is accompanied by an increase in tensile strength and proportional limit and a decrease in elongation or ductility. Within the last few years the introduction of a number of strong and ductile casting alloys led to a study by the material division, Air corps, of the permanence of the physical properties in several of these alloys.

It has been found that even though some alloys have good properties directly after casting or heat treatment, they are not satisfactory for stressed parts that require a combination of strength and ductility. It also has led to the conclusion that all alloys that can be hardened by artificial aging—heating in a temperature range below 170 degrees Cent. (340 degrees Fahr.)—will harden spontaneously if allowed to stand for a sufficient length of time. It follows that, in aircraft work where the factors of safety are limited on account of the necessity of keeping the weight of the structures as low as possible consistent with their safe operation, the properties of the alloys in the stable or final condition should be used as a basis for design rather than the properties obtained on the material directly after casting.

Presents Data

THIS article is abstracted from a paper presented at the Philadelphia meeting of the Institute of Metals division, American Institute of Mining and Metallurgical Engineers, held Oct. 8 to 12. The author is a first lieutenant, air corps, United States army, Dayton, O.

The work of Wilm in Germany, Hanson and Gayler at the National Physical laboratory in England, and Merica, Jeffries, and others in the United States, has shown that the spontaneous hardening is characteristic to a greater or less extent in all aluminum-base alloys in which the solubility in the solid state of the alloying constituents decreases with the temperature. It has been shown that, by heating to a temperature as near as possible to the melting point of the material and soaking at that temperature for a sufficient length of time and then quenching or cooling rapidly, a maximum amount of the soluble constituents can be retained in solution and the condition of maximum hardening effect upon aging can be obtained. Also, in ordinary sand and chill castings, without heat treatment, a sufficient amount of the alloying constituents is held in solution to cause important changes in the final physical properties.

The theory of spontaneous hardening as evolved by Merica is based on the soluble constituents separating out in submicroscopic particles when the material is allowed to stand at

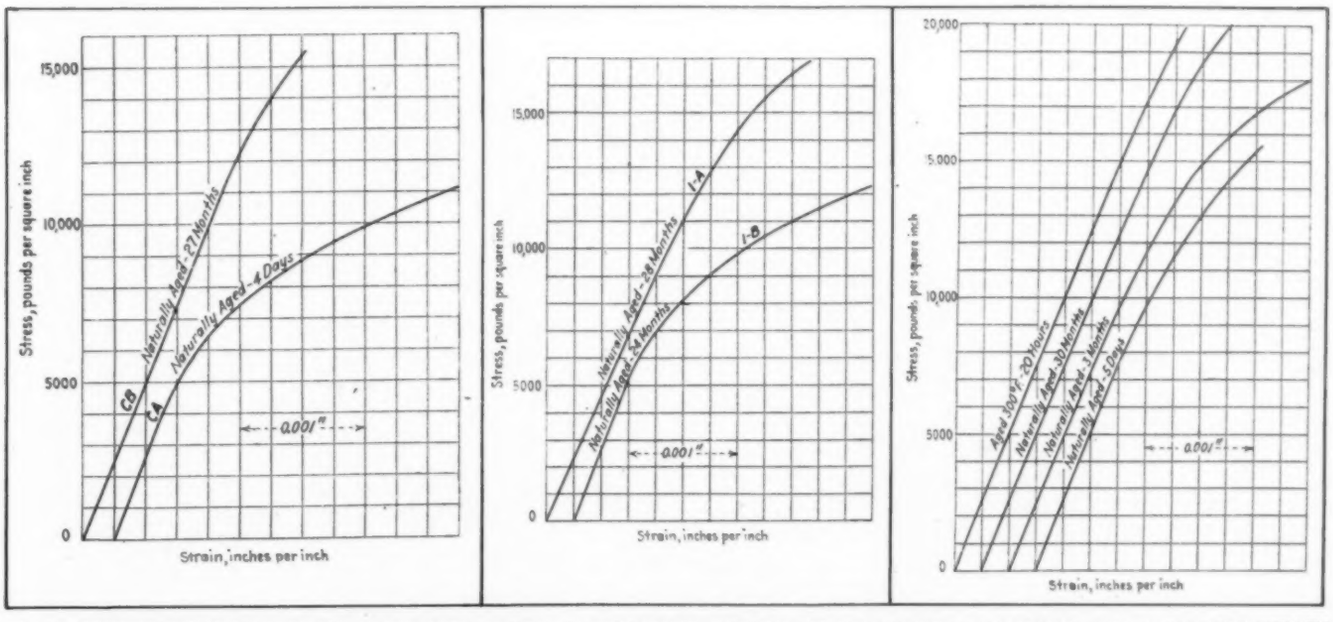


FIG. 1—STRESS-STRAIN DIAGRAM, SAND-CAST ALLOY; 8 PER CENT COPPER, 92 PER CENT ALUMINUM. FIG. 2—STRESS-STRAIN DIAGRAM. SAND-CAST SILICON-ALUMINUM AND COPPER-MAGNESIUM-ALUMINUM ALLOYS. 1-*A* CONTAINS 2.5 PER CENT COPPER, 1.25 PER CENT IRON, REMAINDER ALUMINUM. 1-*B* CONTAINS 13 PER CENT SILICON AND 87 PER CENT ALUMINUM. FIG. 3—STRESS-STRAIN DIAGRAM, SAND-CAST HEAT-TREATED ALLOY CONTAINING 5 PER CENT COPPER AND 95 PER CENT ALUMINUM. HEATED 24 HOURS AT 950 DEGREES FAHR. QUENCHED IN WATER

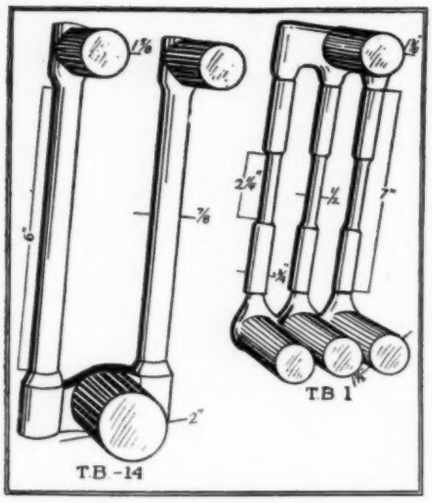


FIG. 4—TEST SPECIMENS

ordinary temperatures. The impression gained from the literature on the subject is that the most important changes take place in a comparatively short time after casting or heat treatment. The scope of this paper is to show that this is not the case for all aluminum and magnesium-base alloys and that in some cases the hardening continues over a period of two or more years. It also points to the possibility that all materials subject to spontaneous aging can be artificially aged in a few hours. When artificially aged, the properties are stable and represent the final properties of the material attained by aging naturally for a period of several years. In other words, the rate of hardening is a function of temperature in the range 0 to 260 degrees Cent. (32 to 500 degrees Fahr.).

The following types of sand-cast alloys were investigated:

1. Aluminum-base
   - *a.* Aluminum-copper
   - *b.* Aluminum-copper-magnesium
   - *c.* Aluminum-copper-nickel-m a g-nesium
   - *d.* Aluminum-silicon
   - *e.* Aluminum-zinc
2. Magnesium-base
   - *a.* Magnesium-aluminum-manga-nese
   - *b.* Magnesium-aluminum-zinc

The test specimens were of the types and dimensions shown in Fig. 4. They were cast in green sand and ordinary foundry practice was observed in the molding, gating, melting, and pouring. The molding sand used for casting the magnesium-base alloys contained from 3 to 5 per cent of flowers of sulphur with a small amount of boric acid to prevent reaction between the water used for tempering and the molten metal. All melting was done in crucible-type furnaces. For the aluminum-base alloys, plumbago or graphite crucibles were used; and for the magnesium-base alloys, cast-iron crucibles. Fluxes were not employed.

Pouring temperature was maintained in the temperature range of 1275 to 1325 degrees Fahr. The maximum furnace temperature was not allowed to exceed the pouring temperature more than 75 degrees Fahr. This is of considerable importance, as it has been shown that the temperature of pouring and the size of the cast section have a considerable effect on the grain size of both the aluminum and magnesium-base alloys. It also is of special importance in connection with the newer types of alloys that require heat treatment to develop their maximum properties, since the coarser the structure, the longer the time required for solution of the soluble constituents.

Incomplete solution has a decided effect on the ductility as measured by the percentage of elongation, the

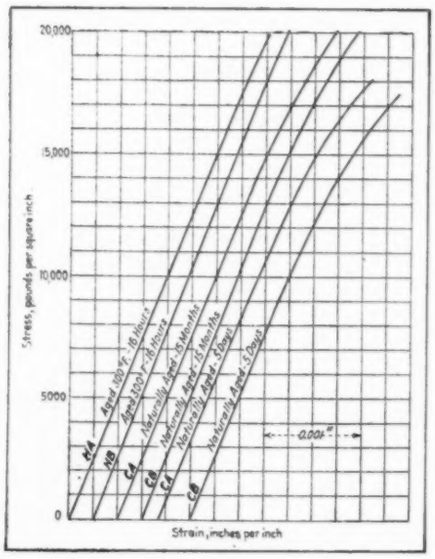


FIG. 5—STRESS-STRAIN DIAGRAM, ALUMINUM-COPPER-NICKEL AND ALUMINUM-COPPER-MAGNESIUM ALLOYS. *A* CONTAINS 4 PER CENT COPPER, 1.5 PER CENT MAGNESIUM, REMAINDER ALUMINUM. *B* CONTAINS 10 PER CENT COPPER, 1.25 PER CENT IRON, 0.025 PER CENT MAGNESIUM, REMAINDER ALUMINUM. *HA* IS HEAT-TREATED 5 HOURS AT 950 DEGREES FAHR. *HB* HEAT-TREATED 5 HOURS AT 925 DEGREES FAHR. *CA* AND *CB* AS CAST

maximum corresponding to complete solution. In the aluminum-copper alloys in the heat-treated condition, a variation of 200 degrees Fahr. in the pouring temperature causes according to a private communication from the research department, Aluminum Co. of America, variations in the ultimate strength of 15 per cent and in the elongation of 40 per cent. In the range of pouring temperatures used in this investigation, the effect on the properties is not of importance. The test specimens shown in Fig. 1 are ½ and ⅞-inch in diameter over the reduced section. The effect of the size of the section is pronounced more on the ductility than on the ultimate strength, and these factors, together with the method of gating, should be borne in mind when comparing results of this investigation with other published information and data.

Chemical composition was determined in all cases on the original melts from which the material used in the test specimens was selected. Slight variations therefore can be expected between the tabulated chemical composition and the actual chemical composition of each individual specimen.

Unless otherwise stated, all specimens were aged under ordinary conditions at atmospheric temperature and were stored under cover. The magnesium alloy specimens subjected to outdoor exposure were placed on racks at an angle of 45 degrees and faced southwest, and were subjected to the atmospheric conditions of temperature and moisture occurring in Dayton, O.

Type *TB*-1 specimens, cast to size ½-inch in diameter over a 2-inch gage length, were tested in a 20,000-pound Olsen machine fitted with self-aligning wedge grips. The ultimate strength was calculated on the basis of the average cross-sectional area over the gage length. The elongation was measured with dividers on the broken specimen to the nearest 1/100 inch. The Brinell hardness tests were made on the tension specimen by grinding flats on the shoulders. A 10-millimeter ball and a 500-kilogram load for 30 seconds were employed in all cases. The impressions were measured by a micrometer microscope.

Type *TB*-14 specimens (Fig. 1), used for determining the proportional limit, were machined from ⅞-inch

Table I

Aluminum-copper Alloy Naturally Aged

Physical Properties	Time 14 Days	Aged 27 Months	Chemical Composition	Per Cent
Proportional limit, lb. per sq. in.	4,600	10,500	Copper	8.05–8.12
Ultimate strength, lb. per sq. in.	17,480	23,270	Iron	0.40–0.57
Elongation in 2 in., per cent	<1.0	<1.0	Silicon	0.36–0.37
Brinell hardness	62	78	Aluminum	Difference

Type of specimen, TB-14; cast ½-in. dia.; machined ¾-in. dia.; gage length, 8 in.

diameter to ¾-inch diameter over a gage length of 8 inches. (The removal of the skin in casting aluminum alloys slightly decreases the tensile properties and also should be taken into consideration in comparing the results obtained from the two types of specimens). The ends of the specimens were threaded to fit adapters. The specimens were then pulled in an Olsen 20,000-pound machine fitted with self-aligning pulling bolts. Loads were applied in increments of 200 pounds, and for each load a corresponding strain over a gage length of 8 inches was read on a direct-reading Ewing extensometer calibrated to read directly to 0.0002-inch. This is equivalent to 0.000025-inch per inch.

These results were plotted to a scale of 1 inch = 500 pounds and 1 inch = 0.00025-inch per inch. The proportional limit was determined by taking the point where the curve first changes slope. The ultimate strength was calculated from the breaking load and the percentage of elongation was determined by measurements on the broken specimen over a gage length of 2 inches. Extreme care was taken in the proportional limit determinations for the reason that it has been found that the stress-strain diagrams afford an accurate means of obtaining information for the study of changes in properties resulting from age-hardening and furnish more reliable data than ultimate strength, brinell hardness, and ductility tests. In the bureau of standards, *Circular* No. 346, 1927, attention is directed to the fact that the yield point is not a definite property, as in steel, and that much of the existing data in the literature fail to disclose the method of determining this property. The introduction of the casting alloys of high tensile strength and ductility has created the necessity for accurate determinations of the yield point or proportional limit.

Table IV

Aluminum-copper-magnesium-iron Alloy

NATURALLY AGED

Physical Properties	Time Aged 2 Days	14 Days	11 Mo.	23 Mo.	43 Mo.
Ultimate strength, lb. per sq. in.	26,530	29,460	31,940	28,088	30,400
Elongation in 2 in., per cent	4.8	4.0	3.5	2.63	3.5
Brinell hardness	57	65	73	71	

Chemical Composition	Per Cent
Copper	2.59–2.66
Iron	1.47–1.55
Silicon	0.17–0.22
Magnesium	0.54–0.60
Aluminum	Difference

Type of specimen, TB-1; cast to size ½-in. dia.; 2-in. gage length.

Table V

Sand-cast Aluminum-copper Alloy

HEATED AT 950° F. FOR 24 HR.; QUENCHED IN COLD WATER

Physical Properties	Aging Temperature and Time Atmospheric 5 Days	3 Mo.	30 Mo.	300° F. 2 Hr.	20 Hr.
Proportional limit, lb. per sq. in.	7,075	9,920	13,625	11,615	15,825
Ultimate strength, lb. per sq. in.	28,135	26,980	29,830	31,155	35,915
Elongation in 2 in., per cent	3.7	2.6	1.2	3.0	1.25
Brinell hardness (500 kg. 10-mm. ball)	74	70	80	75.1	84.1

Chemical Composition	Per Cent
Copper	4.93
Iron	0.62
Silicon	0.84
Manganese	0.03
Aluminum	Difference

Type of specimen, TB-14; cast ⅛-in. dia.; machined ¾-in. dia.; gage length, 8 in.

Gives Aging Effects

Effects of aging at atmospheric temperatures on the 8 per cent and 5 per cent binary aluminum-copper alloys are shown in Tables I and V and in Figs. 1 and 3. The first is the well-known Society of Automotive Engineers alloy No. 12 and is used extensively in aircraft construction for the general run of castings. The proportional limit of this alloy practically is doubled and appreciable changes take place in the ultimate strength after two years' aging at atmospheric temperature. The percentage of elongation of the alloy in the cast condition is so low that accurate comparisons cannot be made. It has been found that, when this alloy is artificially aged at a temperature of 300 degrees Fahr. for 16 hours practically the same changes in ultimate strength as are shown in Table I are obtained in the material in the as-cast condition.

The second of the Al-Cu alloys is a proprietary alloy containing 4.93 per cent copper; 0.62 per cent iron; 0.84 per cent silicon; 0.03 per cent manganese and the remainder, aluminum, which should be distinguished from the sand-cast duralumins that contain small amounts of magnesium. Both are used in aircraft and aircraft engines for parts that are subjected to high stresses and where forgings are impracticable. The straight copper alloy is regarded with more favor than the duralumin-type alloy on account of the better combination of strength and ductility. An examination of Fig. 3 shows that the natural age-hardening continues over a period of 2½ years, the proportional limit then approaching that of the same material artificially aged at 300 degrees Fahr. for a period ranging from 2 to 8 hours. After 20 hours artificial aging at this temperature, the final properties of the alloy are approached.

Artificial aging for this type of alloy has been made mandatory by the Air corps principally on account of the increase in proportional limit. The elongation obtained on the unaged material is misleading. Although the elongation is reduced practically 50 per cent by artificial aging, the ductility is superior to the duralumin-type and the higher copper alloys. Former work done by the engineering

Table II

Aluminum-zinc Alloys Naturally Aged

Physical Properties	Time Aged 1 Day	9 Mo.	20 Mo.
Ultimate strength, lb. per sq. in.	20,850	26,460	30,215
Elongation in 2 in., per cent	5.0	1.2	1.5
Brinell hardness	50.0		65.0

Chemical Composition	Per Cent
Zinc	14.85
Iron	0.46
Silicon	0.45
Aluminum	Difference

Type of specimen, TB-1; cast to size ½-in. dia.; gage length, 2 in.

Table III

Magnesium-aluminum-manganese Alloy

NATURALLY AGED

Physical Properties	Time Aged 1 Day	7 Days	13 Mo.	32 Mo. a
Ult. strength, lb. per sq. in.	24,086	25,820	24,415	22,184
Elongation in 2 in., per cent	6.7	8.0	6.7	6.2
Brinell hardness	45	45	46	44.3

Chemical Composition	Per Cent
Aluminum	4.58
Copper	0.05
Iron	0.05
Manganese	0.3
Silicon	0.03
Magnesium	Difference

Type TB-1; cast round, ½-in. dia. aSpecimens exposed to weather at Dayton, Ohio.

Table VI

Aluminum-copper-nickel-magnesium Alloy

NATURALLY AGED

Physical Properties	Condition and Aging Time: As-cast 5 Days	As-cast 11 Mo.	As-cast 27 Mo.	Heat-treated[a] 5 Days	Heat-treated[a] 28 Mo.
Proportional limit, lb. per sq. in.	9,337	13,730	12,200	14,140	13,580
Ultimate strength, lb. per sq. in.	25,545	25,805	24,235	28,950	30,840
Elongation in 2 in., per cent	Less than 1.0				
Brinell hardness	88		88	97	102

Chemical Composition	Per Cent
Copper	4.13–4.44
Nickel	1.52–1.79
Iron	0.22–0.58
Magnesium	1.51–1.56
Silicon	0.15–0.24
Aluminum	Difference

Type of specimen, TB-14; cast ⅞-in. dia.; machined ¾-in. dia.; gage length, 8 in.
[a]Heat 950° F. for 5 hr.; quenched in cold water; age at 300° F. for 16 hr.

division, Air service on the cast alloys of the duralumin-type and on the binary aluminum-copper alloys by Daniels, Lyon and Johnson, *Transactions*, American Institute of Mining and Metallurgical Engineers, 1925 shows that the alloys containing small amounts of magnesium harden more rapidly than the straight copper alloy and, when artificially aged, reach their maximum after about 20 hours at 300 degrees Fahr. The latter show a gradual increase in ultimate strength up to 160 hours, but at 24 hours the maximum is reached for all practical considerations.

The effect of aging, either spontaneously or artificially, on the wrought alloys of the duralumin type is pronounced more and the time shorter than for the cast alloys of the same composition, according to Archer and Jeffries, *Transactions*, American Institute of Mining and Metallurgical Engineers. The results shown in Fig. 3 would indicate that, if careful determination of the proportional limit is made on the wrought binary aluminum-copper alloy, quenched, and allowed to age at ordinary temperatures, the increase in proportional limit would be of the same order but would take place in a shorter period of time. This is important in connection with the *stocking* of this alloy in the as-quenched condition and then after a period of a year or two subjecting it to forming or severe bending operations in connection with the fabrication processes.

The 10 per cent copper alloy with small additions of iron and magnesium is used extensively in manufacture of aircraft engines, for such parts as pistons and air-cooled cylinder heads, and in other places where high strength and hardness are necessary but the ductility is not important. It is used in both the heat-treated and as-cast conditions. Table VIII shows that in the as-cast condition the alloy reaches a stable condition after about one year at ordinary temperatures. In the quenched condition, aging for 16 hours at 300 degrees Fahr. produces the maximum properties and no further hardening or increase in proportional limit takes place. The effect of increasing the time of artificial aging for periods longer than 16 hours has been shown to produce no appreciable changes in the physical properties, according to Daniels, *Transactions*, American Institute of Mining and Metallurgical Engineers, 1926. An increase in the artificial aging temperature decreases the time required to obtain the maximum properties to a considerable degree. At temperatures from 400 to 500 degrees Fahr., the same results can be obtained in periods of 1 hour or less as for 16 hours at 300 degrees Fahr.

Is High Strength Alloy

The alloy containing 2.5 per cent copper and 0.5 per cent magnesium, which is a duralumin-type alloy, has been used by the Air corps as a high-strength alloy in the heat-treated condition and in the as-cast condition for purposes where a combination of strength and ductility greater than that obtained in the 8 per cent copper alloy is required. The ultimate strength and elongation vary within wide limits for different melts of the alloy of practically the same composition, cast under the same conditions.

Results in Table IV are representative of the maximum rather than of the average properties, but are included to show the effect of aging at ordinary temperatures over a period ranging from two days to 3½ years. The effect of magnesium, as mentioned before, is to decrease the time required for the alloy to reach its stable condition. During the first two weeks, the hardening progresses rapidly and then slowly up to about a year. The results tabulated for periods greater than a year are within the range of properties obtained from different specimens from the same heat and aged for the same length of time. The tests on *TB*-14 specimens, which have not been included in Table IV, gave an ultimate strength of 24,000 pounds per square inch, a proportional limit of 8000 pounds per square inch, and an elongation of less than 1 per cent. These properties should be compared with those given for the 5 per cent aluminum-copper alloy, Table V. This alloy furnishes a good example of the misleading results that can be obtained from alloys of this type if not properly aged before testing.

Physical properties of the alloy containing 4 per cent copper, 2 per cent nickel, and 1.5 per cent magnesium are practically of the same order as those of the copper-magnesium alloy just described. It is commercially known as *Y* alloy and there are also a number of compositions with somewhat the same properties which are known under a trade name. Table VI shows that it is in a stable condition after aging at 300 degrees Fahr. for 16 hours. Like the copper-magnesium alloy, however, the same results can be produced by shorter reheating periods at a higher temperature; 500 degrees Fahr. appears to be the upper limit of the reheating range for this alloy. In the as-cast condition the principal change upon aging at atmospheric temperature occurs in the proportional limit. The alloy appears to be more stable in this condition than the aluminum-copper-magnesium alloy, and the proportional limit directly after casting is appreciably higher. It appears that the improvement in properties by heat treatment is derived from the heating at elevated temperature and the quenching operation more than from the subsequent aging. This alloy is used for pistons and air-cooled cylinder heads and, although slightly more difficult to cast on account of the higher percentage of magnesium,

Table VII

Modified Aluminum-silicon Alloy

NATURALLY AGED

Physical Properties	Time Aged 3 Mo.	Time Aged 24 Mo.
Proportional limit, lb. per sq. in.	3,700	4,275
Ultimate strength, lb. per sq. in.	24,975	26,110
Elongation in 2 in., per cent	5.38	4.09
Brinell hardness	60.0	59.4

Chemical Composition	Per Cent
Silicon	13
Aluminum	87
Modified (Pacz Method)	

Type of specimen, TB-14; cast ⅞-in. dia.; machined ¾-in. dia.; gage length, 8 in.

the improved propertites at elevated temperatures such as are met in aircraft engines warrant its use.

Aluminum-silicon alloys, which include the normal and modified types, are not subject to spontaneous hardening, or age-hardening. They are practically stable in the cast condition. In the normal alloy a small improvement of the elongation may be obtained through heat treatment, but no appreciable changes in the ultimate strength or proportional limit take place. In Table VII are shown results of tests made after 3 months and 2 years aging, respectively, at atmospheric temperature, on a commercial grade of the modified alloy containing 13 per cent silicon and 87 per cent aluminum. The physical properties listed are within the range obtained on individual test specimens from the same lot of metal and tested under the same conditions. In passing, it should be observed that, although this type of alloy has an attractive combination of ductility and ultimate strength, the proportional limit is low and should prevent the alloy being placed in the class of the high-strength alloys. The Air corps has attempted to use this material for important and highly stressed fittings, such as control fittings and landing-gear fittings. There are records of failures resulting from the gradual stretching and distortion of the part due to suddenly applied loads above the proportional limit but well under the ultimate strength. A typical stress-strain diagram for this alloy is shown in Fig. 2. For the purpose of comparison, a diagram of the low-copper, duralumin-type alloy in the as-cast condition is also shown. These should be compared with the stress-strain diagrams of Fig. 3.

Aluminum-Zinc Alloys

Binary aluminum-zinc alloys are not recommended for use in aircraft, but there are several combinations of zinc, copper, and aluminum that have found their way into aircraft engines on account of the good combination of strength and ductility which can be obtained without heat treatment. The results shown in Table II indicate that the 15 per cent aluminum-zinc alloy is unstable and the ultimate strength increases 50 per cent after 2 years aging at atmospheric temperature. This increase in ultimate strength, however, is accompanied by a loss of ductility of such magnitude that it would prevent the alloy being used for purposes where ductility is important. The change in properties of the aluminum-zinc alloy is the one exception in the commercial alloys referred to in this paper in which the hardening effect is not due to the decrease of the solid solubility of the alloying constituent with temperature. It is probable that the hardening is a result of a phase change and that the reaction, according to Rosenhain, *Journal*, Institute of Metals, 1911, that takes place at approximately 256 degrees Cent. (492 degrees Fahr.) proceeds slowly at ordinary temperatures. It has been stated that the addition of copper does not affect the temperature of this reaction, so that the results shown in Table II represent what can be expected of all alloys that contain zinc as the principal alloying constituent. In addition to the loss in ductility, this alloy is not suitable for aircraft use on account of its higher specific gravity, nonresistance to corrosion, and weakness at elevated temperatures. It has been dropped from all Air corps specifications.

On account of the specific gravity, as compared with that of the aluminum-base alloys, the alloys of magnesium offer attractive possibilities for use in aircraft and aircraft engines. The magnesium-aluminum alloys are stable in the as-cast condition. The results of tests on the 4 per cent aluminum alloy are included in Table III. Tests also have been performed on the 8 per cent and 12 per cent magnesium-aluminum alloys, without manganese, and show stable properties. In Table III the ultimate strength as determined from specimens aged out of doors is slightly lower than those aged indoors. This is on account of a slight reduction in cross-sectional area due to corrosion. There is no loss in ductility, however, and the hardness is of the same order.

Results of tensile tests on specimens with the zinc content ranging from 3 to 5 per cent and the aluminum content from 5 to 3 per cent are shown in Table IX. These, unlike the results for the binary magnesium-aluminum alloys, show pronounced aging properties at ordinary temperatures. There is a pronounced improvement in the ultimate strength and a slight increase in ductility. The hardness remains approximately the same. An examination of the equilibrium diagram for the magnesium-zinc system, Chadwick, *Journal*, Institute of Metals, 1928, shows that on the magnesium end of the diagram the solid solubility of the zinc as a compound $MgZn_2$ decreases rapidly with temperature.

From this it would follow that the principle underlying the hardening of this type of alloy is the same as for the binary aluminum-copper or the aluminum alloys containing magnesium silicide. The results of the aging tests on two typ s of magnesium-base alloys, shown in Tables III and IX, indicate that there is little choice between them from a practical standpoint. In cast sections neither is appreciably corroded by the atmospheric conditions of Dayton, O., notwithstanding the fact that they received no protection except the presence of the skin which forms during the casting. These alloys have recently been included in Air corps specifications.

Table IX

Sand-cast Magnesium-aluminum-zinc Alloys

NATURALLY AGED

Physical Properties	Composition and Time Aged: Al, 5.71; Zn, 2.90; Mg, Difference				Zn, 4.94; Al, 3.19; Mg, Difference			
	1 Day	2 Mo.	13 Mo.	34 Mo.[a]	1 Day	2 Mo.	13 Mo.	34 Mo.[a]
Ultimate strength, lb. per sq. in.	20,090	25,180	23,435	23,178	23,666	24,150	26,905	26,255
Elongation in 2 in., per cent	3.2	4.3	4.6	5.0	4.8	4.1	5.2	5.3
Brinell hardness	49	49	50	50	49	50	54	54.2

Type TB-1; cast to size, ½-in. dia.; gage length, 2 in. [a]Exposed to weather conditions of Dayton, Ohio.

Table VIII

Aluminum-copper-magnesium-iron Alloy

NATURALLY AGED

Physical Properties	Condition and Aging Time: As-cast			Heat-treated[a]		Chemical Composition	Per Cent
	5 Days	15 Mo.	28 Mo.	5 Days	28 Mo.		
Proportional limit, lb. per sq. in.	7,920	10,550	10,500	15,030	15,800	Copper	9.65
Ultimate strength, lb. per sq. in.	20,890	22,135		25,860	28,600	Iron	1.38
Elongation in 2 in., per cent	Less than 1.0					Silicon	0.39
Brinell hardness	88	97	99	110	105	Magnesium	0.28
						Aluminum	Difference

Type of specimen, TB-14; cast ¾-in. dia.; machined ⅝-in. dia.; gage length, 8 in.
[a]Soak 925° F. for 5 hr.; quench in water; age 16 hr. 300° F.

Trade and Technical Associations Presented Exhibits of Castings and Products Attesting Qualities of Members' Products

Foundries Display Wares

National Metal Exposition Affords Opportunity for Castings Makers to Present Their Products to Large Users in the Consuming Industries

DIVERSIFIED arrays of foundry products were displayed at the tenth National Metal Exposition which was held Oct. 8 to 12 inclusive at the Commercial Museum, Philadelphia under the auspices of the American Society for Steel Treating with the American Welding society co-operating. A wide assortment of steel castings was exhibited at the booth of the Electric Steel Founders Research group, Chicago. Companies associated with this group included the Sivyer Steel Castings Co., Milwaukee; the Nugent Steel Castings Co., Chicago; Michigan Steel Castings Co., Detroit; Lebanon Steel Foundry, Lebanon, Pa.; and, Fort Pitt Steel Casting Co., Pittsburgh. Numerous photographs were arranged in sequence to show the various operations involved in the production of steel castings. In addition photographs of the plants of the companies associated with the group were shown. Maj. R. A. Bull, research director was in charge.

Samples of castings were arranged attractively on a display table showing the types and classes produced by the member concerns. The display included in excess of 60 pieces ranging from ½-pound to 500 pounds. Different kinds of apparatus for testing sands, a machine for testing baked cores, a device for preparing test pieces, apparatus for testing the permeability of sand, and, a machine for testing the bond of various grades of sand were available for inspection. Specimens of alloy steels and their fractures in test for, and, alloy steel castings normalized and drawn to show the physical qualities were shown.

The Gray Iron Institute, Cleveland, presented statistics of the industry which it represents and the objects and purposes of the organization which was making its first appearance before the users of its product. Castings were exhibited which showed the physical qualities, corrosion resistance and other merits of gray iron in industrial service. A cast-iron fireback, made over 150 years ago was provided by a local foundry which owns this relic. Arthur J. Tuscany, manager, Cleveland and Albert E. Walton, eastern representative, were in charge.

Steel castings made and strengthened under carefully controlled heat treatment were exhibited under direction of George Batty, by the Steel Casting Development bureau, Philadelphia. Companies co-operating with the bureau included Atlantic Steel Castings Co., Chester, Pa.; Pennsylvania Electric Steel Casting Co., Hamburg, Pa.; Empire Steel Casting Co., Reading, Pa.; Dodge Steel Casting Co., Philadelphia; Deemer Steel Casting Co., New Castle, Pa.; and, Crucible Steel Castings Co., Lansdowne, Pa. Castings shown included heavy coil springs, herringbone gears, rack and pinions, tractor shoes, and an automobile truck rear end housing. Normal, annealed and heat treated structures of plain carbon and special alloys steels were illustrated. An additional display of physical test specimens and photomicrographs was found at this booth.

Centrifugally cast bronze in various sizes, lengths and forms, and made of standard and special compositions in the rough, semifinished and finished state were available for inspection at the booth of the Shenango-Penn Mold Co., Dover, O. The product shown varied in weight for each piece from 1 to 1000 pounds and was in the form of solids, tubes, bushings, sleeves and liners. Solids and tubes were shown in the rough state while bushings, sleeves and liners were displayed both in the rough, semifinished and finished condition. The American Manganese Bronze Co., Philadelphia showed various specimens of manganese bronze castings. Brass, copper and bronze tubing, rods, forgings, castings and fittings were displayed at the booth of the Mueller Brass Co., Port Huron, Mich. Heat resisting castings were shown by Driver-Harris Co., Harrison, N. J. and Chrobaltic Tool Co., Detroit. High temperature alloy castings such as carburizing boxes, pots, baskets, retorts, furnace rails, plates and trays were included in the display of Michigan Steel Casting Co., Detroit.

Various fittings and other appli-

(*Concluded on Page* 897)

Heavy Boiler Sections *Are Made* on a Production Basis

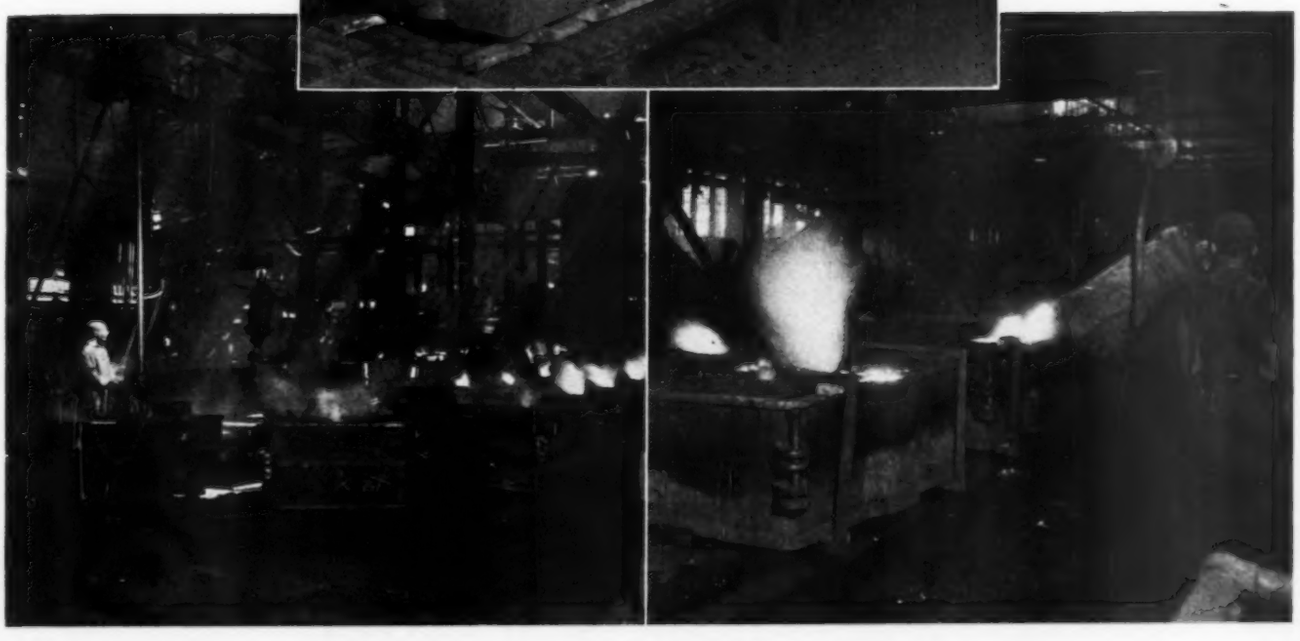
By Edwin Bremer

ALTHOUGH many instances have been presented where smaller types of castings have been put on a production basis by the adoption of mold and sand handling units, the application is not so wide spread for the production of large castings. In one of the previous articles of this series the method used in the Bond plant of the American Radiator Co., for the production of small castings in the plate foundry was described. This article will describe the production system as applied to the manufacture of boiler sections.

To show the size of work produced in the boiler foundry, attention is called to Figs. 16, 17, 18 and 23. The first three illustrations show the flasks and equipment in the foundry and the last illustration shows a boiler section undergoing a water test. The boiler foundry is about 150 x 300 feet and contains 20 units devoted to the production of boiler sections. Although the mold handling units vary slightly and show added refinements according to the period at which they were built, the prin-

Fig. 16 (*Right*) —*In This Unit Drags Are Made on the Right and Copes on the Left Side. The Molds Are Closed on the Center Roller Conveyor*

Fig. 17 (*Left Below*) — *Large Molds Are Shaken Out with Vibrators Attached to Yokes. Fig.* 18 (*Below*) — *Heavy Sections Are Poured by Crane*



ciple employed is the same in each unit.

This principle includes making the drag and cope on machines arranged in pairs, setting cores and closing the molds, a mold handling system to convey the molds to the pouring station, a shakeout, a mold handling system to return the empty flasks to the machines, and a sand handling system. A typical unit is shown in Figs. 16 and 17. This shows the use of gravity roller conveyors to carry the finished molds and a hoist to return the empty flasks to the machines.

Fig. 16 shows the head or molding end of the unit. The short conveyor on the right, as may be seen, is used to carry the cores to the place where the molds are closed. Cores for this conveyor are brought from the core room on skids and unloaded on the conveyor. As the cores are used, they are pushed up from the other end, a distance of approximately 20 feet. Molding machines for the various units in the boiler foundry were supplied by the Milwaukee Foundry Equipment Co., Milwaukee, and by the Herman Pneumatic Machine Co., Zelienople, Pa. The machines are arranged in pairs; one machine is used for making drags and the other for copes. The molding machines are jolt, rollover type and employ pneumatic clamps for holding the flask in position. Air hoists with yokes that slip over the flask trunnions are used to transport the empty flasks to the machines, and carry away the molds.

When a drag mold is made on the machine, it is picked up by a hoist and carried to the roller conveyor which is situated approximately in the center of the unit. The cores are placed in position and a cope mold is brought from the cope making machine. The cope is lowered as shown in Fig. 16. Large, tight fitting pins at diagonally opposite corners locate the position of the two parts of the mold. After the mold is closed, clamps are placed on opposite sides of the molds near the four corners and wedged into place to prevent any movement or shifting of the flasks.

From 10 to 15 men are employed on each unit. These include one man making drags, one man making copes, one man to finish the drags and one to finish the copes. In addition to these men two are engaged in shaking out the molds, two men pour the molds and another sets the cores in place. A gang leader is in charge of each unit. He oversees all operations and inspects the molds for defects.

Where found necessary, he assists in performing any of the operations. From 8 to 15 molds are produced an hour, depending upon the type and size of boiler section being made. Payment of the various operators of the unit is made on the number of good castings produced. A rate is set for each class of work.

Fig. 17 shows the pouring and shakeout end of the unit. The molds are poured along one side, which in this illustration is at the right. When the molds reach the end of the conveyor system, the cope is lifted off by a yoke to which two vibrators manufactured by the Malleable Iron Fittings Co., Branford, Conn., are attached. The mold then is moved over the shakeout grating and the valves opened on the vibrators. The rapid motion of the vibrators soon removes the sand from the flask. The yoke and vibrators attached to a flask may be seen in the center of Fig. 17.

When the cope is lifted off, the casting is picked up by an eccentric clamp which fits over two opposite sides and placed to one side as may be seen at the left of Fig. 17. Then the drag is lifted from the conveyor and shaken out. Empty flasks are carried up to the molding machines by pneumatic hoists. Sand which falls through the shakeout grating is carried on a conveyor belt to a bucket elevator which raises it to a sand retempering apparatus. From the retempering unit, the sand is conveyed to the storage hoppers over each molding machine. Since a large the discharge gate on the bottom of the hopper is a motor driven apron feeder supplied by the Link-Belt Co. As long as the apron is in motion, sand is delivered to the flask, but when the power is shut off the feed stops. Fig. 18 shows one of the units producing sections for some of the largest boilers made in the Bond plant. To give some idea of the size, the molds shown in

Fig. 20 (Center) —Grinding the Ribs of Small Boiler Sections. Fig. 21 (Below) —Method of Handling Cupola Charges

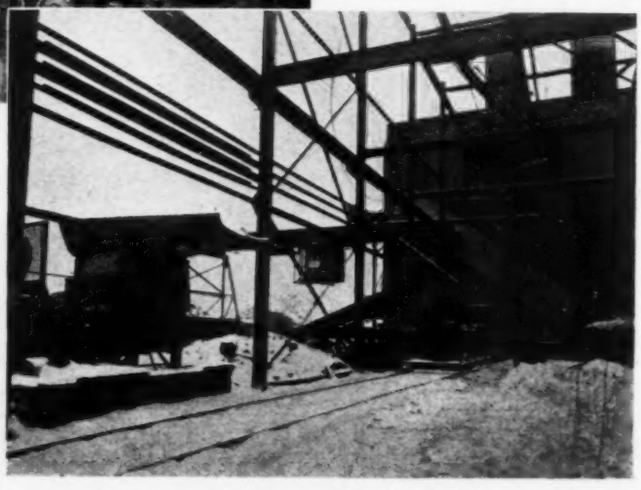


Fig. 19 (Upper Left) — Partly Burned Core Sand Is the Base for Synthetic Molding Sand Used Throughout the Foundries

this illustration are about 5 feet square. Due to the large size and weight of the flasks they are handled by cranes supplied by the Whiting Corp. As may be seen also in this illustration, cranes also are used in pouring. The molds are shaken out in a manner similar to that just described except that cranes instead of hoists do the lifting. The sand falling through the shakeout grating is elevated to the sand retempering apparatus and from there it is conveyed by belt to the hoppers above the molding machines.

Molding sand for all the molding units in both the boiler foundry and the plate foundry is made synthetically from partly burned core sand from the cleaning department of the boiler foundry, and clay. The partly burned sand is transported to the sand department in a railroad car as shown in Fig. 19. The sand is dumped into an elevator boot supplied by the Link-Belt Co., and raised to a storage hopper. Just before passing into the storage hopper, the sand passes over a vibrating screen supplied by the same firm. This breaks up lumps and removes extraneous material.

From the storage hopper a batch of sand is admitted to a muller type sand mixer made by the National Engineering Co., Chicago. A clay from the Olean district, and seacoal are added to the sand and mixed thoroughly. The approximate quantities of materials used are 70 per cent partly burned molding sand and 30 per cent clay. After these constituents have been mixed, from 3 to 5 per cent seacoal is added. The amount of seacoal added depends upon the purpose for which the sand is used. More seacoal is used in sand for castings requiring a smooth finish such as is desired on doors, and other plate work on furnaces.

Molten metal for the various molding units in the boiler foundry is supplied from two sets of cupolas placed at one end of the foundry but on opposite sides. That is to say the cupolas are on the east side of the foundry with one at the north end and one at the south. As in the plate foundry, the cupolas are arranged in pairs, and operate on alternate days. While one is in use, the other is being repaired. Each of these cupolas melts at the rate of about 22 tons an hour, or 200 tons in a 9-hour shift. Operation, of course, is continuous during this period. One cupola operates for a 9-hour shift and the other operates from 22 to 24 hours a day. In the long shift the cupola will melt between 450 and 500 tons of metal.

Due to the large amounts of metal and coke needed for charging, a rapid system of charging was developed. This system is unique in the small number of men needed for handling 200 tons of metal, 23½ tons of coke, and 6 tons of limestone used during a 9-hour shift. Only four men are employed to handle approximately 230 tons of material.

This low handling cost is accomplished by unloading the pig and outside scrap directly from the railroad cars by a magnet attached to a crane, into a pneumatically operated, weighing scoop shown at the left in Fig. 21. Remelt scrap is picked up from the yard where it is dumped. When the proper amount of metal is placed in the scoop by the crane operator, an electrically operated larry car, shown close to the building at the right in the illustration, containing bottom dump buckets, is run under the scoop. The operator of the larry car the pulls the lever which dumps the material from the scoop into one of the dump buckets. The car operator then runs the car to the end of a portable conveyor where the coke is discharged into the other bucket on the car. Coke is unloaded from hopper bottom, gondola cars into a measuring hopper by an attendant. The measuring hopper discharges on the portable conveyor and then, as mentioned into the bucket. The larry car operator then runs the car close to the building. Here the cupola charging crane mounted on a monorail several feet above the charging floor picks up the buckets, transports them to the cupola where they are dumped, and returns them to the car below. As may be seen in Fig. 21, the charging crane enters the cupola building through a wide doorway in the upper wall.

Metal is transported from the cupolas to the pouring stations in ladles holding about 800 pounds, by an

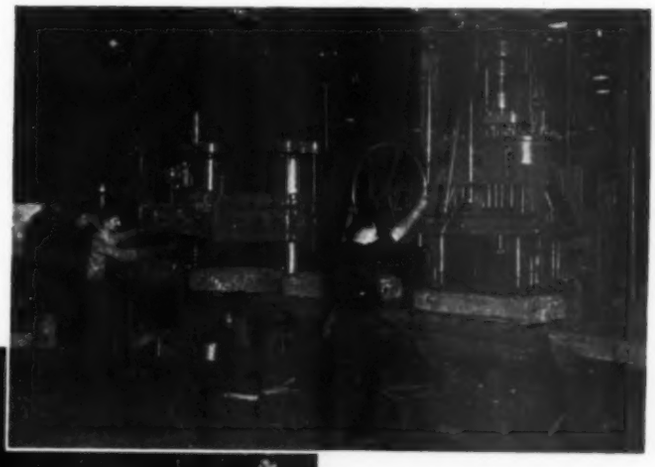


Fig. 23 (Below) — Sections Undergoing a Water Test for Leakage. Fig. 24 (Right) — Multiple Drilling and Tapping Machines

Fig. 22 (Left) — Inspectors Constantly Check the Reaming Operations with Plug Gages

electrically operated crane suspended from a monorail. The cranes used were supplied by the Shepard company and the monorail by the Louden company. A view of one pair of cupolas is shown in Fig. 25. As may be seen in this illustration, large mixing ladles with a capacity of two tons are placed in front of each cupola. This gives a more uniform iron than would be obtained by catching from the spout, and the mixing ladle also acts as a reservoir for holding the molten metal. A simple hook device on the crane is used for picking up the ladles, and is operated from the cab.

As may be seen in Fig. 25, the hook is formed from a single bar bent into a loop with a short leg and a long leg. The hook proper is formed on the end of the short leg, and the long leg is left straight. The long leg acts as a fulcrum and holds the short leg in such a position that when it is brought up under a ladle bail it engages it so that it may be lifted. However, when the operator wishes to disengage the ladle, he lowers it to the floor and gives the hook a little slack. Then by pulling up on a wire attached to the long leg of the device, the hook is swung back out of the way, and the hook may be raised without engaging the bail of the ladle. This makes it easy to handle the ladles.

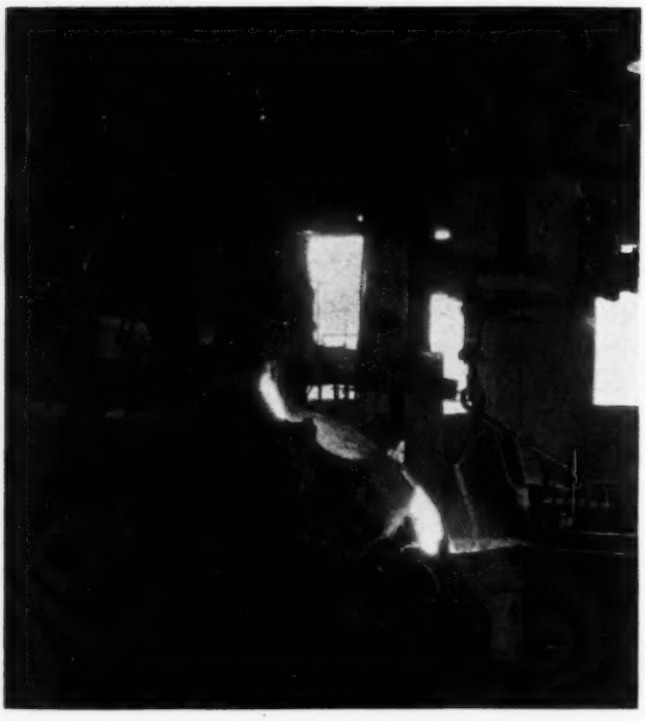


Fig. 25—Cupolas Arranged in Pairs Are Used on Alternate Days. Cab Cranes Transport the Molten Metal to the Pouring Stations

After the castings have cooled they are carried on skids into the cleaning room where the core sand is removed. This is accomplished by vibrators attached to pneumatic hoists. The vibrators have hooks at the ends which are placed in one of the openings in the boiler section. The section is raised from the floor and the rapid jarring action of the vibrator causes the partly burned core sand to run out one or more of the openings at the lower end of the section.

When all the core sand is removed from the section, it is taken to the sandblast cabinets where the surface is cleaned. Since a large number of sections must be handled each day, ordinary methods of handling would be slow and cumbersome. Consequently a mechanical system was developed to carry the sections through the sandblast cabinets of which there are five supplied by the Pangborn Corp., American Foundry Equipment Co., and the Northern Blower Co. The mechanical system employed consists of a monorail track arranged in circular form which passes through the cabinet. Suspended from the monorail on trolleys are long hooks. These hooks engage one of the numerous openings, preferably that at the top of the boiler section. Narrow openings in the sides of the sandblast cabinets allow the castings to pass through. Movement of the castings through the sandblast cabinets is controlled by hand.

From the cleaning room the castings are taken to the water test department where they are subjected to an interior water pressure of 80 to 100 pounds per square inch. Each boiler section has three openings, one at the top and one near the bottom of each leg. As may be seen in Fig. 23, clamps with rubber gaskets are fastened to the openings in the legs. A similar clamp with a water opening is attached to the inlet at the top. The valve is opened and water admitted to the section. While the section is under pressure, all parts of the casting which is turned on a horizontal axis, are scrutinized for leaks. If any cracks develop, the section is discarded without any attempt at reclamation. During the water test, all fins or burrs are knocked off the sections. Following the water test, such places as where the gates were attached, fins at the mold joint, and rough spots are ground off smoothly by portable electric grinders.

When this is completed, the castings are inspected, weighed and sent to the surface grinding department. In this department, the joint ribs are ground parallel to each other, and the sections from the face of one joint rib to the surface of the opposite joint rib are made the same thickness. The joint ribs referred to, are around the edges of the various openings such as the firebox, and water openings. On the front and back sections of the boiler, a rib running around the outer edge is placed only on the inside where it butts against the intermediate sections. On the intermediate sections, this rib is on both sides.

Automatic Grinding

Grinding machines similar to that shown in Fig. 20 are employed. Each section is placed in a large frame and held in the proper position by pneumatic clamps at the top and one end. The boiler section and frame then are passed automatically between two large vertical grinding wheels which remove any excess metal from the ribs. After the section has passed between the wheels, the machine is reversed, and the casting and frame come back to the position shown in Fig. 20. The thickness of the section is gaged to see that it meets the specifications. The section then is removed and placed to one side.

Following the grinding operation the sections go to the machining department where the various holes for attaching doors, smoke hoods, etc., are drilled and tapped on multiple spindle machines as shown in Fig. 24. As may be seen in this illustration, roller conveyors are used to facilitate the movement of the castings. The castings are machined on a straight line production plan, and when a casting leaves the conveyor, all the neces-

(*Concluded on Page* 897)

The FOUNDRY Family Photograph Album

Upper Left

D. F. EDWARDS
Saco-Lowell Shops
Boston

Lower Left

F. J. GARTSIDE
Diamond Clamp & Flask Co., Richmond, Ind.

Upper Right

ZAY JEFFRIES
Aluminum Co. of America, Cleveland

Lower Right

D. E. McLAUGHLIN
Pacific Coast Steel Co., San Francisco

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

A LEXICON OF TECHNICAL TERMS

(*Continued from Data Sheet No.* 738)

Martensite

Martensite is a transition form between austenite, and ferrite and cementite. When austenite breaks down into its constituents, ferrite, carbon (graphite) and iron carbide, Fe_3C (cementite), it goes through certain transition forms. These forms usually occur in the following order and are called martensite, troostite, sorbite, and pearlite.

Martensite has a characteristic needle-like structure and is always an indicator of great hardness. It is the hardest form in which the iron carbon alloy exists. Martensite of eutectoid composition (0.89 per cent carbon) has been called *Hardenite*. Transition forms are found more

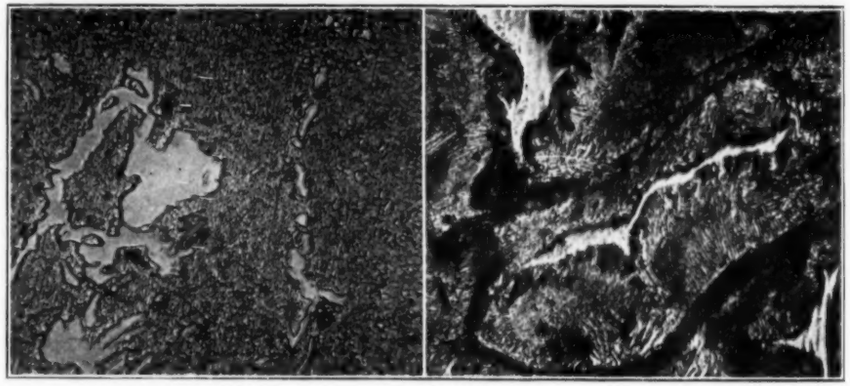


FIG. 13—CEMENTITE—ETCHED, X 1000. FIG. 14—GRAPHITE AND PEARLITE—GRAY CAST IRON—ETCHED, X 500

frequently in the heat treated specimen. The structure of martensitic steel is presented in Fig. 10.

Sorbite

Sorbite is also a transition form. Its characteristic granular structure is recognized easily under the microscope. A sorbitic structure is an indication of the best combination of strength properties in a steel and is the form in which most of the ordinary steels are used. This structure is shown in Fig. 12.

Pearlite (Laminar and Granular)

Laminar pearlite is the constituent of a steel of a eutectoid composition (0.89 per cent carbon) when slowly cooled. It occurs in the characteristic laminar structure shown in Fig. 8 in untreated steels and cast irons. The granular form is usually a product of heat treatment and is considered

(*Continued on Data Sheet No.* 740)

A LEXICON OF TECHNICAL TERMS

(*Continued from Data Sheet No.* 739)

the final product of transition from austenite.

Cementite

Cementite is the iron carbide constituent Fe_3C. It is hard and brittle. In cast steels and cast irons it occurs unevenly dispersed in various forms throughout the alloy. This has the effect of producing nonuniform hardness and hard spots and is an important consideration from a machining standpoint. It is also called cementation carbon, cement carbon, carbon of annealing, normal carbide, carbide carbon, cementitic carbide.

Segregated cementite or noneutectic cementite are the names sometimes applied to the carbide constituent of pearlite. Pearlite-cementite, pearlitic

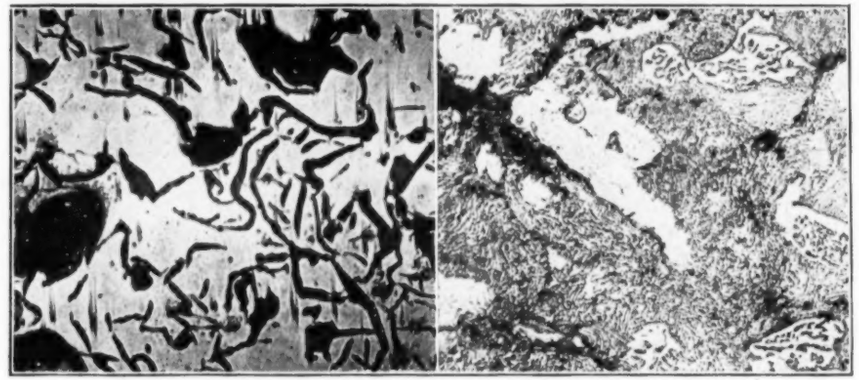


FIG. 15—TEMPER CARBON—ANNEALED CAST IRON—RELIEF POLISHED, X 100. FIG. 16—INTERMETALLIC COMPOUNDS—BRASS—ETCHED, X 400

cementite, or eutectoid cementite are the terms recommended.

Free cementite (surplus carbide or massive cementite) occurs independently in irregular masses throughout the alloy.

Pro-eutectic or primary cementite, is the term used (Howe) for cementite, forming before eutectic forms, and the pro-eutectic cementite is for cementite forming before the eutectoid is formed.

Total cementite has reference to the total of all different forms of cementite. It has a magnetic change or transformation point at 215 degrees Cent. (Honda). The light colored areas in Figs. 13 and 14 are cementite.

Ledeburite

Ledeburite is the eutectic of iron carbon series (4.3 per cent carbon). See Eutectic Properties and Fig. 7.

(*Concluded on Data Sheet No.* 741)

How and Why in Brass Founding

By Charles Vickers

Threading Is Difficult

We are having difficulty making pressure castings of aluminum alloys which appears due to porosity and dross. Also the threads are not clean cut, the metal appears suitable for tapped threads but die cut threads strip. We are using 88 pounds of virgin aluminum, 12 pounds of 50-50 copper-aluminum alloy, and add ½ pound of 0.50 per cent silicon copper. We melt the aluminum and the hardener together, then add the silicon alloy and stir well. We also add a tablespoonful of salammoniac for a flux. We have to overheat the aluminum a little to dissolve the silicon hardener. Then we chill to silver color and pour. We melt in a crucible with a coke fire, and we do not like to change the mixture unless for one that is sure to give us less trouble. Some heats are perfect and thread beautifully. We sometimes use a remelt aluminum made from clippings supposed to be pure. This mixture is free of zinc so far as we know. We are interested in knowing the cause of the imperfections, whether it is the material purchased, the melting practice, the mixture used, or wrong molding methods. The castings weigh one pound each and we cut a heavy gate, and the height of the head is four inches with a 2-inch sprue.

Nothing appears to be wrong with the material purchased, or the alloy which is a 6 per cent copper-aluminum alloy, also the clippings are not objectionable, even though they are likely not to be pure, but alloyed. We do not understand what the addition of ½ pound of 0.50 per cent silicon copper means. Perhaps it is meant that ½ pound of a 50-50 silicon-aluminum alloy is added. We are unable to understand what advantage could be gained by this addition, and feel that it would be better to add 13 pounds of the 50-50 hardener, to 87 pounds of the virgin aluminum and omit the silicon copper.

Addition of silicon will not help the threading operation any, but increasing the copper content by decreasing ductility does render the metal more easily machinable. Because some of the heats come perfect and thread beautifully, we are inclined to put the blame on the melting operation for the porosity of the castings. Merely getting the aluminum hot enough to dissolve silicon copper will do no harm, for aluminum that has been unduly overheated in the furnace, will make sound castings if cooled to as low a temperature as possible for pouring. This *low as possible temperature* means as cool as it is possible to fill the molds completely. In the case of a one-pound casting of massive section this would be around 1250 degrees Fahr., or a trifle under.

Coke-fired crucible furnaces are capable of giving liquid aluminum that will pour sound castings, for this is done every day. More care will have to be taken while melting is going on, and we think your trouble is here. The pot cannot be filled with enough cold metal at one charge. It is filled, the furnace is run until all is melted and additions are periodically made. The busy furnace tender finds it too easy to forget his aluminum with the result that it gets to a white heat sometimes, and this is often as a number of charges have to be made to fill the pot. This kind of overheating does the damage, and this is the thing to watch. It may pay to put a man to attend only to the aluminum melting furnace with strict injunction to see that at no time during the melt is the charge permitted to get heated beyond a clear blood red.

We are not able to pass upon the molding methods as these have to be seen to be appreciated, but the sprue is too heavy, a riser 2 inches diameter on a casting that is liable to shrink somewhere is common practice, but a sprue 2 inches in diameter is something else. It is so large the falling stream of metal can carry air down with it, on the principle of the tromp air blast. The sprue should not be larger than one-inch in diameter, the height is about what is commonly used for aluminum.

Alloy Withstands Bends

We would like to get the formula for the cheapest and best alloy to use for battery terminals. These have to be bent quite often before they break and so a ductile alloy is needed. They are lead coated after being finished.

An excellent alloy for bending is the following: Copper, 72.50 per cent; sheet yellow brass scrap, 25.00 per cent, and tin, 2.50 per cent.

Uses Oil-Sand Core

We would like to get a mixture for a core sand that can be used without venting as it is for a water jacket core 12 inches diameter; 12 inches long and ¾-inch thick with two half-inch holes to get the gas off. We understand that glue is the binder generally used for such cores.

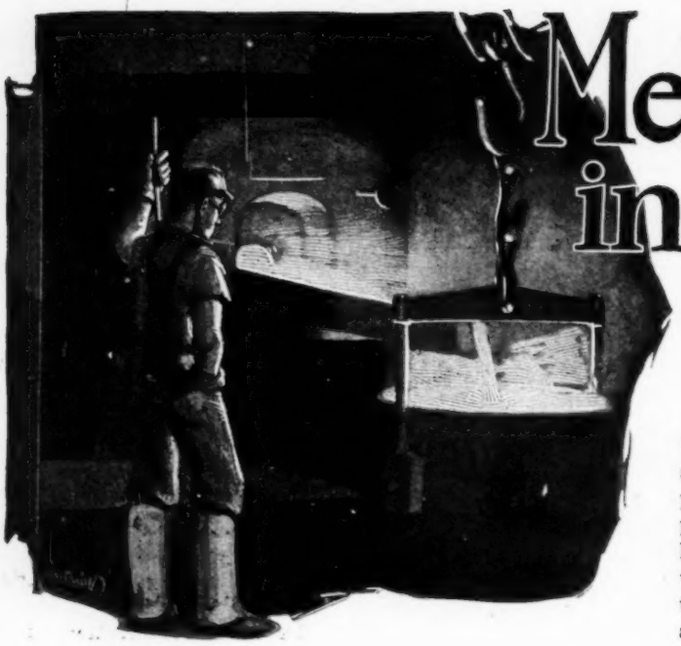
Whenever molten metal surrounds a core, there is going to be some evolution of gas. If this gas is unable to escape easily to the atmosphere, the casting is going to suffer somewhere.

Thus the first consideration is to have a sand that when bonded into a core will be so open that the gas can find its way through it by passing between the grains and to meet these conditions the core should be of all sharp sand. The bonding agent generally is linseed oil, using as little as possible to get the strength needed. No formula is required for making such cores, except that not less than 60 parts of sand are used to one part of the oil. To use glue for cores the adhesive has to be dissolved in hot water and the solution used to dampen the sand. As sufficient glue has to be used to give the requisite strength, and as the amount required will not be the same for different sands, it is necessary to determine the correct amount of glue to add for any locality by direct experiment. Make a standard watery solution of glue, then add to a definite amount of sand. If the core is too weak use a stronger solution.

Desires Bronze for Mine

We are desirous of obtaining an acid-resisting bronze for use in connection with pumps that go into mines. At times the water contains sulphuric acid and at other times sulphuric acid with ferric acid in combination. Have you any data along this line?

The waters of this mine, like most other mines changes in corrosive properties from day to day and so a metal that will stand up well on one day will show up badly on another. Under such conditions experience has shown the following alloy when properly put together will stand up well in mine work. The formula is; copper, 70 per cent; tin, 10 per cent and lead, 20 per cent.



Melting Iron in the Cupola

By J.E.Hurst

Part V

GETTING the best out of a cupola does not end with melting the hottest iron or with the lowest coke consumption. Smoothness of operation, freedom from detail troubles, tap hole trouble, scaffolding, breakouts, operation with the minimum damage to the lining and repair work are all equally important in the efficient operation of the cupola.

In practically every respect, cupola practice is an art and the personal intelligence, skill and experience of the operator are finally responsible for the continued efficient operation of the cupola under any particular circumstances. Cupola detail practice varies in individual foundries and it is impossible in a description of this nature to do more than deal with the more important of the details and methods involved. This can be done most conveniently by dividing the subject into four sections under the following subheadings: (a) Preparation of the cupola for charging; (b) charging the cupola; (c) melting the iron; (d) special purpose devices.

The first job in the preparation of the cupola after clearing away and sorting the dump from the previous day's melt, is to chip out the excessively large lumps of slag and cinder material adhering to the lining. This is followed by daubing or coating the lining up to the melting zone region with refractory material. If the slaggy projections are allowed to remain, they are likely to increase in size after continued melting, and ultimately cause scaffolding or bridging. The larger lumps of material, usually found above the tuyere openings, generally are removed by prodding and poking with a long heavy bar, with or without the assistance of a sledge hammer. The smaller soft and porous accumulations and all hard slag projections are removed by the operator inside the cupola, armed with a sharp pointed, short handled pick.

It is not necessary to chip off the smooth coating of slag, covering the lining, but it is good practice to penetrate this coating at intervals with the sharp pointed pick. This gives the daubing material, subsequently applied, the opportunity of adhering to the underlying brickwork. The practical operator before commencing the chipping operation invariably sluices the walls of a dry cupola with water. This precaution alleviates the personal inconvenience caused by dust. It is also advisable, particularly when other workmen are present, to close the charge hole doors, or to provide a shield across the cupola shaft above the operator to prevent stray bricks or other material falling down the shaft.

After the chipping operation, the lining is coated from the hearth to above the melting zone with a refractory plastic material. Ganister, or a fireclay and sand mixture, with sufficient water added to make into a plastic mass, are the materials commonly used for this purpose. In the course of the melting operation, the cupola lining invariably is corroded by the action of the heat and the slag forming materials, particularly in the region of the melting zone. The principal object of the daubing operation is to make good this corrosion and restore the lining to its original shape. At the same time, all special defects, such as loose bricks, large holes, caused either in melting or chipping out, are repaired and a smooth lining of the desired shape obtained.

Plastic material used, should be highly refractory and at the same time, sufficiently plastic to adhere to the walls and form a hard lining of substantial mechanical strength after firing. The plastic material should be sufficiently wetted with water to enable it to be thrown on the lining by hand, with considerable force, to enable the material to penetrate any cracks and the joints of the brickwork. When the whole of the lining has been covered in this manner, the plastic material is smoothed with a trowel. The author prefers to use daubing material in the dryest possible state in which it can be used, without loss of plasticity. The material can be spread, or forced on by hand, or rammed and tamped with a wooden rammer.

Before the plastic material is applied, the lining is wetted thoroughly with clay wash. Large holes are filled with pieces of broken firebrick and plastic material. Good practice favors stopping even small holes with broken firebrick, rather than with plastic material. After the plastic material is applied and smoothed,

Preparing the Furnace

UNDER the two general heads "Preparation of the Cupola for Charging" and "Charging the Cupola," intimate and detail instructions are given for chipping, daubing, making up the bottom, the breast, the slag hole and the tap hole. With everything in readiness, consideration is given to the many problems incident to calculating the amount of coke on the bed and between the charges, also the manner in which the charges should be made up and placed in the cupola to secure the best results.

some men favor copious venting by piercing the layer of daubed material with a 1/8-inch to ¼-inch diameter, sharpened spike. This never can do any harm and assists in preventing the material from cracking and flaking off during the drying period when the steam is escaping. The daubing never should be too thick. It is advisable to maintain an average thickness not exceeding 1 inch. To prevent the need for excessive daubing this operation is carried out systematically before every melt.

With the daubing finished, the next operation is to make the sand bottom. The bottom doors are closed and locked in position, either by the usual prop and wedge, or other form of locking device provided. The bottom doors usually are closed by hand although various devices have been developed for this purpose particularly for use on the larger cupolas.

Requires Great Care

Making up the sand bottom is an operation which requires great care. Nothing is more annoying, irrespective of the danger arising therefrom, than a leak or a breakout of the molten metal through the bottom doors. The choice of refractory materials for this purpose is limited practically to a good bonded sand. Fireclay, or other materials with a large clay content, set so hard under the influence of the heat, that difficulty is experienced in dropping the bottom and getting the material out of the cupola when the melting operation is finished. Some operators lute the bottom door joints with fireclay as a precautionary measure, although this is not really necessary if the sand bottom is well made.

Good tough molding sand, is thrown on the closed bottom doors and carefully rammed particularly around the circumference and across the center joint to a minimum depth of about 3 inches. The bottom is arranged to slope upward from the tap hole about ½ to 1 inch to the foot. In cupolas with two tap holes, the bottom is sloped to lead to both. Care always should be exercised not to make the bottom hollow, or saucer shaped. This is a frequent source of breakouts. The ramming should be done carefully, not too hard, but exactly as in a hard rammed mold. The surface then is smoothed carefully with a trowel and any soft spots made good and hard. Some foundrymen still cling to the antiquated clay wash finish on the bottom, but the practice is not favored by the new school of melters.

Forming the tap hole depends upon the particular arrangement of the cupola. In some cupolas, the tap hole is embodied in a large hole or breast, which requires to be closed by a suitable breast plate after the cupola is lighted. Generally, the tap hole opening in a modern standard cupola is small and the tap hole is formed by ramming a mixture of fireclay and sand, around a taper rod placed in the opening in the brickwork. The clay mixture is rammed tightly in position, and the hole is made about 2 inches diameter on the outside, tapering down to about 3/4-inch or 5/8-inch on the inside.

Many operators prefer a parallel tap hole about 1 inch diameter. They

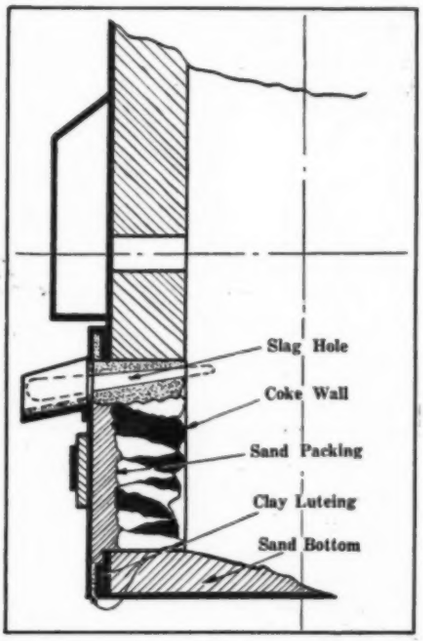


FIG. 34—ILLUSTRATED METHOD OF CLOSING FETTLING BREAST AND SLAG HOLE

cut away the front portion of the rammed material to leave a hole 2 to 3 inches in length. When the blast is put on, the tap hole is left open, and the flame issuing through the hole dries the clay material and burns it to a degree of hardness sufficient to withstand the continued prodding and poking of the tapping bar. In good practice a quantity of plumbago, or ordinary foundry blacking is mixed with the fireclay and sand. Iron and slag are less likely to stick in a tap hole of this kind. Specially burnt firebricks, or bricks made of material similar to that in plumbago crucibles, are manufactured with the tap hole embodied. One can be built into the brickwork to form a permanent tap hole. In a cupola with a large breast opening, the breast and tap hole are filled in exactly the same manner as the fettling breast and slag hole to be described later. The tap hole requires more careful preparation of course than used in the slag hole.

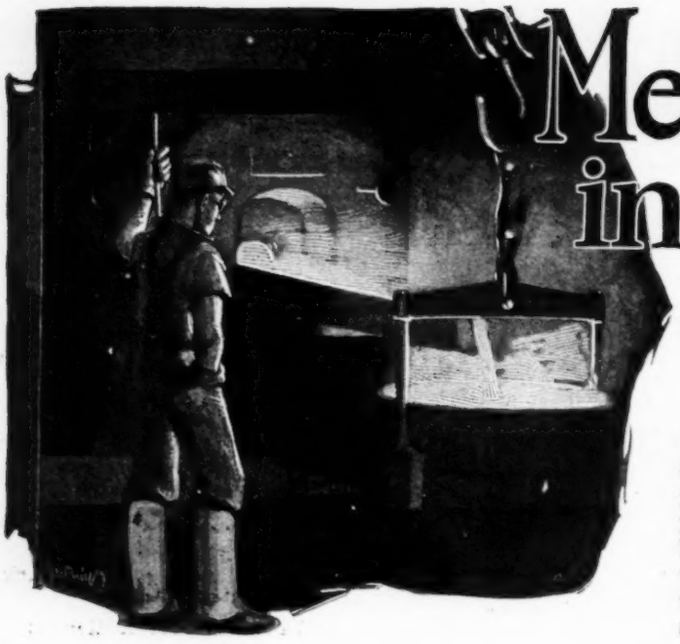
With most cupolas either a tap hole breast or a fettling breast is provided for the convenience of the operator making up the bottom and the inside of the tap hole after closing the bottom doors. This breast is filled in after the fire has been lighted and a portion of the bed coke charged on the bottom of the cupola.

The manner of filling the breast is shown in the illustration Fig. 34. A wall is built from selected pieces of coke. Where a slag hole is required, it is formed in like manner to the tap hole round a taper bar, placed in the desired position. The coke wall, wetted with clay water, is covered with a layer of tough molding sand, or black sand from the foundry floor. The breast plate, luted round the edges with fireclay, is placed in position and forced tightly against the sand, by wedges, screws or other form of locking device. Tightening the breast plate consolidates the sand against the coke wall, making a tight and safe closure.

Charging Bed Coke

The tapping spout is lined preferably with good loamy sand, rammed into position. An even slope should be made without hollows in which the metal stream can lodge, and it is advisable to originate the lining of the tapping spout from a point about 1 inch below the bottom of the tap hole. This is indicated in Fig. 20, Part IV, and shows how the tap hole may be botted clearly. The tapping spout should be given a good coating of blackwash and carefully dried by lighting a wood fire along its length. This concludes the preparation. The cupola then is ready for charging and melting.

Under the conditions of operation in a shaft furnace in which the air is injected into a column of incandescent coke, a definite zone is established over which the temperature attained by the combustion is at a maximum. This zone commonly is referred to as the melting zone, and is at a higher level than that of the top tuyeres. Existence and character of this melting zone are discussed more fully in a later chapter. Sufficient to point out at this stage that if the melting zone assumes a well defined upper limit under any given conditions, then the initial bed coke should be charged up to this level. Additional coke charges should be sufficient in amount to replenish that part of the bed burned away in melting the iron charge. If the initial bed coke charge is higher than this limit, the initial melting will occupy a longer time, and the iron possibly



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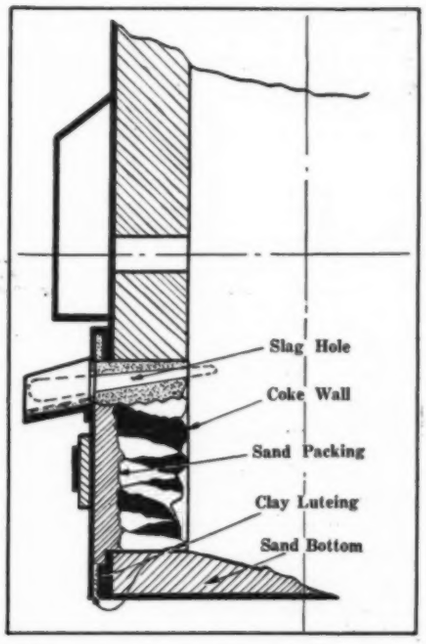

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will be cold. If the bed coke height is less than this limit, the iron will be cold, and danger of scaffolding is imminent, due to unmelted metal getting down into the tuyere zone.

The upper limit of the melting zone in any given cupola is determined by a number of conditions including temperature, pressure and velocity of blast, character of coke, combustibility, ash content and the like. Influencing factors are so many, correct height of the bed coke cannot be stated dogmatically. Determination should be a matter of actual experiment for every individual cupola. In the words of Kirk "To do good melting, the melting point must be discovered and only a sufficient quantity of fuel placed on the bed to bring the top of the bed up to the melting point."

To ascertain the correct height of the bed coke the observer notes the time from putting on the blast to the commencement of melting. This time should not exceed 10 to 12 minutes. If the time is unduly long, the bed coke is too high. If the iron appears in less time but is dull and cold, the bed coke is too low.

These observations on the correct height receive general confirmation from appearance of the burnt out portion of the cupola wall after melting. This locates and fixes the height of the melting zone. From many observations the general rule is that the bed should be from 8 to 12 inches above the top tuyeres. In ascertaining the correct height for any individual cupola good practice suggests starting somewhat higher than this, and gradually reducing the height to the minimum possible without affecting the temperature and character of the iron. Height of the bed coke can be ascertained readily by using a light rod cut to the required length and inserted through the charge hole.

A large portion of the bed coke generally is charged and the fettling or tap hole breasts are not closed finally until this is well alight up to the tuyere level. Before any further charging takes place, it is desirable that the bed coke shall be thoroughly alight. The tuyere doors are allowed to remain open to promote a natural draft through the stack. Where for any reason this process is too slow the speed of burning often is increased by the introduction of an air blast. This can be introduced through the slag hole or through a special tuyere, technically known as a kindling tuyere provided at a low level for this purpose. This tuyere must be stopped with fireclay when melting commences. The regular blower sometimes is used, either throttled down or with the blast gate in the pipe nearly closed. Oil burners also have been recommended for igniting the bed coke. The breast is left open for the application of the burner and is not closed until the bed is well alight.

The metal portion of the cupola charge consists of pig iron and scrap iron, or steel of various sorts. With each charge, or with a given number of charges, a quantity of limestone is added to flux the sand on the pig iron, and the coke ash. A charge of coke is required to replenish that part of the bed burned in melting each charge of iron.

The first charge of iron is placed on the well lighted bed, followed by its quota of coke. Succeeding charges of iron and coke follow in alternate layers until the stack is filled to the charging door sill. It is still common practice to make the first charge of iron heavier than those which follow it. In some places the first charge is doubled. No good reason can be adduced in defense of this practice. The object of good charging, is evenly distributed layers of iron and coke. Owing to the observed tendency of the flames to creep up the sides of the cupola, it is probably desirable to distribute the charge toward the outer circumference.

Weight of individual metal charges vary according to the diameter of the cupola. They should never exceed the maximum weight of metal that would be melted by the coke contained in the melting zone. The accompanying Table V indicates the limiting weights of individual charges in various cupola diameters. The table is based on the assumption that the average depth of coke in the melting zone is 1 foot and that 1 pound of coke will melt 10 pounds of iron. Weight per cubic foot of piled coke varies between 28 and 40 pounds. A value of 30 pounds per cubic foot has been used in the table.

Recent experiments on the continent have demonstrated the most suitable height of the coke charge to be about 0.59 feet. On the assumption of this value as the minimum thickness of the coke charge layers, the weights of the metal charges for different diameter cupolas have been calculated.

Table V

Limit the Weight of Metal

Diameter, inches	Area, Sq. Ft.	Volume of coke in melting zone, Cu. Ft.	Weight of coke in melting zone, Lbs.	Limiting Wt. of metal charges, Lbs.
10	0.5	0.5	15	150
20	2.25	2.25	67.5	675
30	5	5	150	1,500
40	9	9	270	2,700
50	13.6	13.6	408	4,080
60	20	20	600	6,000

New Officers Head Sand Research Committee

Following the resignation of B. D. Fuller as chairman of the American Foundrymen's association committee on molding sand research, Fred Erb, Erb-Joyce Foundry Co., Detroit, and vice president of the A. F. A., has been appointed general chairman of the committee. Mr. Fuller retains his interest in the committee's activities and remains on the executive committee.

A new position, that of technical director, has been created in the committee's organization and Dr. H. Ries, head of the department of geology, Cornell university, Ithaca, N. Y., has been selected to fill the position.

Dr. Ries has been connected with the work of the committee since its inauguration in 1921, first as chairman of the subcommittee on geological survey of foundry sand resources and later as chairman of the subcommittee on tests. One of the most eminent of economic geologists of the country and authority on clays, Dr. Ries was a pioneer in investigating foundry sands, for his work in 1904-05 on the surveys of the foundry sand resources of Michigan and Wisconsin was perhaps the earliest systematic investigation of foundry sands. For his earlier work in connection with the committee in its development of sand testing methods, honorary membership in the American Foundrymen's association was conferred on Dr. Ries.

The committee on molding sand research, organized in 1921 as a joint committee of the A. F. A. and of the engineering division of the National Research council, under the chairmanship of Mr. Fuller, recently issued its second volume of standard and tentatively adopted methods of testing and grading foundry sands.

Bill Hears Queer Doings In Brass Shop

By Pat Dwyer

THERE is one thing," said Bill the other night, apropos of nothing in particular, "there is one thing I never could, and for that matter never can, and probably never will understand."

"One?" I said, "dear lad, you flatter yourself or maybe your memory is slipping. If I wanted to, or if the subject warranted the labor and concentration involved, I could mention 40, yes, 41 things you don't, never will and probably never could understand. However, to save time—according to the gross materialists among whom we live, the most precious of all commodities—you may whisper to me just what is sitting heavy on the intellect at the moment. Is it animal, vegetable or mineral and am I allowed more than three guesses?"

"Well, now, do you know," Bill replied, "since you place it in that light I am more puzzled than ever. Offhand I could not tell you which of these three great classifications covers it. Depending on the point of view, the stuff may be any one of the three. That is a point I had not considered. The feature that puzzled me is why people eat it."

"Eat what?"

"Cheese."

"Cheese?"

"Yes, c-h-e-se, or c-h-e-i-s-e or c-h-e-y-s, or—what difference does it make how you spell it? The smell remains."

"You want to know why people eat it?"

"Do you know the answer?"

"Well, why do people eat any kind of food? I don't see anything odd about eating cheese, or anything in the situation to puzzle any person even of ordinary, or at a pinch—even subnormal—intelligence. If you really want to know why people eat cheese and if you can't figure it out for yourself, I'll tell you. They eat it because they like it and because they are hungry!"

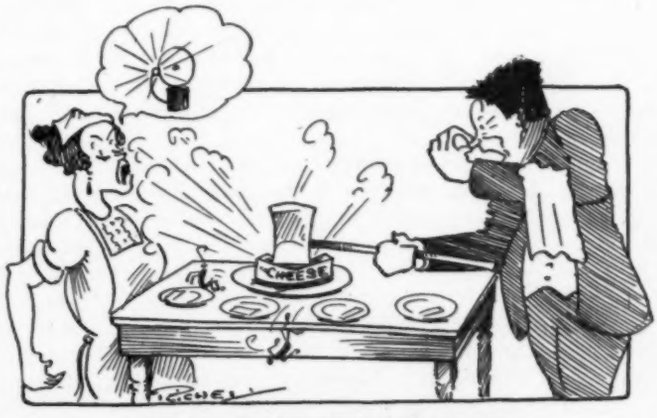
"Not the kind of cheese I am talking about," said Bill, "the kind that partakes of all three classifications, animal, vegetable and mineral. I cannot conceive of any pangs of hunger becoming severe enough to tempt a person to touch the stuff. Dust and heat inhaled constantly over a period of many years in the foundry, practically have ruined my sense of smell. I am immune under ordinary and even some extraordinary conditions. A visit to the stockyards, to a glue factory or to a tannery produces no ill effects, but the presence of a dab of this cheese within a radius of 15 or 20 feet of where I sit is sufficient to drive away all appetite and send me into the street gasping for air. I do not need to see it any more than these blindfolded lads who pose for their pictures with a cigaret between their fingers and a kind of foolish grin on their mugs. Whenever a hunk of that stuff comes into a room, I go out!

"If I were to follow a natural impuse, as I have been tempted many times, I should have the waiter bring me a few decayed, thoroughly decayed eggs which I should open quietly either on or under the table and then stand on my constitutional rights. Surely I have the same right as my neighbor to maintain a nuisance.

"Unfortunately, or perhaps fortunately, depends on the point of view, I never have mustered sufficient courage to carry out this counter offensive. I have hesitated to mention the subject to others and sometimes I have wondered if I am alone in my antipathy to this most maledorous of all substances offered for human consumption. Recently while browsing through a noble volume compiled from the scrap books of the nation I found a ringing and fearless denunciation of a certain species of cheese. No author's name was attached to this treasure. Therefore, I am prevented from writing him or her a hearty letter of congratulation. The views and opinions of the writer coincide so closely with my own that I copied the thing and would have showed it to you half an hour ago, if you had stowed the gab instead of chattering away like a blinkin' magpie. Listen to what this anti-cheese champion, standing firmly on a de-odorized and sterilized platform, has to say."

Rouquefort cheese is made in France from the milk of a certain breed of sheep, fed on wild thyme and the cheese has a wild time trying to escape its own aroma and thus preserve life in its early days.

"See that," said Bill, "the author starts right in with a good swift swinging upper cut at the stuff in its infancy."



HE AIN'T DONE RIGHT BY OUR NELL

The wild thyme grows on the banks of the Lot, the Tarn and other rivers in the department of Aveyron in France. After it first has been besheeped and then becheesed it generates a lot of the darndest smells that ever perambulated down the pike. Thyme is a kind of an aromatic plant with a pungent odor. After it has been converted into Roquefort cheese it is the pungiest thing known to mankind.

"Hard words me hearties," Bill commented, "but listen. The worst is yet to come."

After this cheese is made

it is put into solitary confinement until its whiskers begin to turn gray and gangrene sets in. Then it is taken out and chained to a post. Before it is served, it is chloroformed or knocked on the head with an axe. Preference usually is given the latter method. If the users could be treated in a similar manner every person would be happy and the world would be a better—and purer—place in which to live. It is then brought to the table in little square sections about the size of a domino—no, not a mask, although the reference to a mask is a happy thought. The cheese is served at the close of the meal with black coffee. Clearly this is an error of judgment or probably may be taken to indicate that the hostess is not familiar with the potent virtues of sheep dip and formaldehyde. It (the cheese) usually has a running mate in the shape of a small round cracker that has to be broken with a maul. Gents with short, weak teeth generally skip the cracker.

"You will notice in the next paragraph," said Bill, "evidence supporting my view that the stuff may be any one or all three, animal, vegetable and mineral."

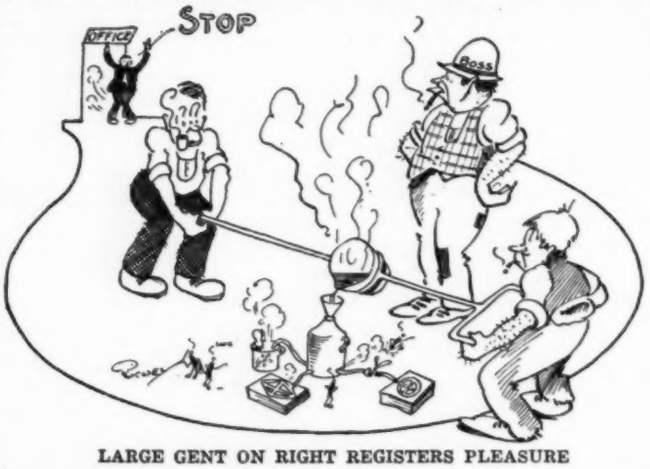
Roquefort cheese is of a dull white color, except in spots where mortification has set in. Some claim that it is inhabited, but eminent scientists differ in opinion on this point. The majority hold to the belief that even the intrepid and mephitic microbe flees from it as from a pestilence. Some Limburger cheese is strong enough to shoulder a two-bushel sack of wheat, but a piece of Roquefort the size of a dice can carry an election. Limburger is a rose-geranium when compared with Roquefort. There is as much difference between them as there is between the purr of a kitten and the roar of a lion. Some people who claim to be civilized say they like Roquefort cheese, but they eat it only because it is imported and expensive. A man who will eat it is an open sepulchre and should be quarantined or driven into the wilderness and never again allowed to look into or breathe into the face of a human being.

"I trust," Bill remarked inquiringly, "I trust you get this anti-cheese bird's meaning. He is against it and he does not care who knows it. It is a great pity that foundrymen cannot be equally free and frank in discussing abuses that prevail in the industry.

"I met a lad the other day who told me of a peculiar experience he had recently. For the sake of convenience I'll call him Dick, because that is not his name. Dick is a good old name, rolls easily from the tongue and all that kind of thing. It is an easy, informal name compared with the dignified Richard and is more in keeping with the familiar, democratic spirit which prevails inside the four walls of the foundry.

"For obvious reasons I shall follow the same system in bestowing names on other characters, also in quoting certain figures. I could give you the actual names and figures, but you don't know the people and so far as you are concerned, one name is as good as another. Facts, my boy, are the only things which count and I shall pass them along to you substantially as I heard the story.

"Dick is a highly skilled brass foundryman who learned the business under his father, a foundryman of the old school. The father established the business many years ago and it is now continued by his sons on a considerably enlarged scale. They have a long list of customers including one company which insists on the highest quality in materials and workmanship. This company lays down a rigid set of specifications to which the castings must measure up in every particular, or, back they go to the scrap pile.



LARGE GENT ON RIGHT REGISTERS PLEASURE

"Dick knows his business inside and outside. He knows his costs and, contrary to the haphazard methods of some foundrymen, he does not believe in conducting his business as a charitable institution for the benefit of his customers. He turns out good castings and he insists on a price that will insure an adequate return for his skill and knowledge, for the risk involved in a hazardous business, for his continued reputation and for the capital invested. When he gives a customer what he wants he feels he is as fully entitled to a proper recompense as men engaged in any other profession.

"When a contractor builds a house he does not sell it to the customer for the price of the materials. A doctor does not charge a patient merely for the medicine supplied. A tailor charges more than the price of the cloth when he makes a suit and the same analogy might be continued indefinitely. Therefore, why should a foundryman supply castings at a price that merely covers the price of the metal. That's a fair question, hey???"

"Never mind asking conundrums," I said. "How do I know? Go ahead with the story. I hope it has a favorable—and happy—ending and they all lived happily thereafter."

"Yes," said Bill, "it had a happy ending, but believe me, before it came to an end brave Dicky went through a Gethsamene equal to that of the hero in any of the good old ten—twent'—thirt' meller drammers filled with buzz saws, runaway locomotives, degraded villyans and dirty work at the cross roads. For three rousing acts he was buffeted cruelly by an unkind fate, but in the last act the villyan was knocked for a row of tin cans and our hero collected heavy dough."

"Sounds good," I admitted. "Run up the curtain and bring on Act 1."

"Run up the curtain!" said Bill. "What do you think I am, a squirrel? Act 1 commences with an inquiry from Percy, the purchasing agent of this big company I mentioned, for terms and delivery date on a large bronze sleeve weighing about 1200 pounds in the rough. Dick told him he could make the core that day and pour the casting the following day. The casting would cost—well, let us say 40 cents a pound.

"'Fine,' says Percy. 'Our truck will bring the corebox and pattern right over.'

"Dick made the necessary preparations for handling the job, but the pattern and corebox failed to turn up. The following morning Percy telephoned that he had been in touch with another foundry which had offered to make the casting for 25 cents a pound and in justice to his company he had felt obligated to accept. He regretted the necessity of taking the job away from a foundry that always had given satisfaction, but he was sure Dick would realize his position and if there was any way of compromising on the price and so forth—

"Dick admitted he was sorry to lose the job, but 40 cents was his figure and that was the end of it. However, he begged to point out that the second foundry was not equipped to handle a casting of that character and that probably Percy was letting himself in for a large gob of grief. Percy affected to consider this a bit of light and airy persiflage. He laughed pleasantly and clicked the receiver on the hook.

"A couple of days later he called up again . The second foundry had

fallen down on the job and had given it up and the machine shop was hollering for the casting. He wanted the casting as soon as possible and was willing to pay Dick's price.

"'O. K.' says Dick, 'I'll cast it tomorrow about noon time.'"

"He started the core immediately and had it in the oven that night. The following day he made the mold and melted the metal. He was all set to pour the casting when Percy notified him in a great hurry to hold up the job. Dick tried to argue him out of his unreasonable position but could not get any satisfaction. Finally he told him that if he had to stop the job at that stage he would have to add to the price. Then he poured the metal into ingots.

"About 2 o'clock Percy notified him that everything was all right. He now could go ahead and pour the casting.

"'Are you sure this time?' says Dick.

"'Oh, absolutely,' said Percy. 'Can you ship it this afternoon?'

"'Yes,' said Dick, 'in a pig's eye. What do you think this is? A cafeteria or hot dog stand? I'll have to melt the metal again.'

"He melted the metal again and was just on the point of taking it from the furnace when he was called to the telephone. Percy was up in the air this time for fair. The machinist had bored the hole 5/16-inch over size in the part designed to receive the bronze sleeve and as a consequence the diameter of the sleeve would have to be increased. He asked Dick if he could attend to this trifling detail.

"By this time Dick's goat was at the end of its tether. He (Dick, not the goat) mentally consigned Percy, all Percy's ancesters and descendants, his castings and the foundry business in general to a place where temperatures in excess of 3000 degrees Cent., currently are reported to prevail. In a word, if you take my meaning, he was mildly irritated. He told Percy all this in a few well chosen words. He said, 'Sure! I'll fix her up for you, but the job will set you back 5 cents more per pound.'

"He poured the metal into ingots for the second time. Then he took the mold apart and lifted the core out and set it to one side while he doctored the mold.

"The mold was made originally in a fairly tight fitting flask and naturally, increasing the diameter of the casting reduced the margin of sand between the mold cavity and the sides of the flask. He decided to incur the extra hazard in preference to selecting a larger flask and making a complete new mold. He dismissed the shop crew at the regular quitting time and only kept a couple of men to handle the mold and the metal.

"He prepared two semicircular pieces of wood with an outside diameter equal to the proposed outside diameter of the casting. The sand was scraped away at each end of the mold and the semicircles were bedded into place. An opening on the inside of the flanges 3 inches less in diameter than the outside served as a guide for a straight strike with a shoulder at each end.

"The depth of the shoulder was 1½ inches to correspond with the width of the face of the flanges, but both flanges and shoulder might have been cut to any other convenient dimensions. The upper part of the strike ends rested on the wood flanges, and the beveled edge of the straight part removing the necessary 5/32-inch thickness of sand from the face of the mold. Each half of the mold was treated in a similar manner.

"At the proper time the ingot, with the necessary additions to compensate for past and present melting loss, was placed in the furnace. The mold was finished and reassembled and finally poured shortly before midnight. Dick put on his coat and thankfully called it a day. On the following day he shipped the casting and when he presented his bill it went through without a murmur.

"Now there is a combination of circumstances that might not come together again in 40 years, but it serves to illustrate the point that the foundry is about the last place in the world for any person seeking a rest cure. They say (whoever *they* are) that care killed a cat. According to all accounts a cat has nine lives, so you can figure out for yourself what chance a man has with only one.

"In this instance he had a choice of three methods for enlarging the diameter of the casting in a mold already made. He could shake the mold out, attach lagging strips of wood or any other convenient material to the pattern, and make a new mold. That would take considerable time and the job was in a hurry. The second and third methods involved about the same amount of pattern work and material, with the balance slightly in favor of the second method. The second method was adopted as I explained a few minutes ago. Here, I'll make you a sketch of the second and third methods and you can see the difference."

Here Bill extracted a little stumpy pencil from one of his pockets and made the original of the accompanying sketch.

"Sketches are great things," he said, "for conveying the meaning from one person to another. One look at a drawing conveys more to the mind than a flock of words. Even if only

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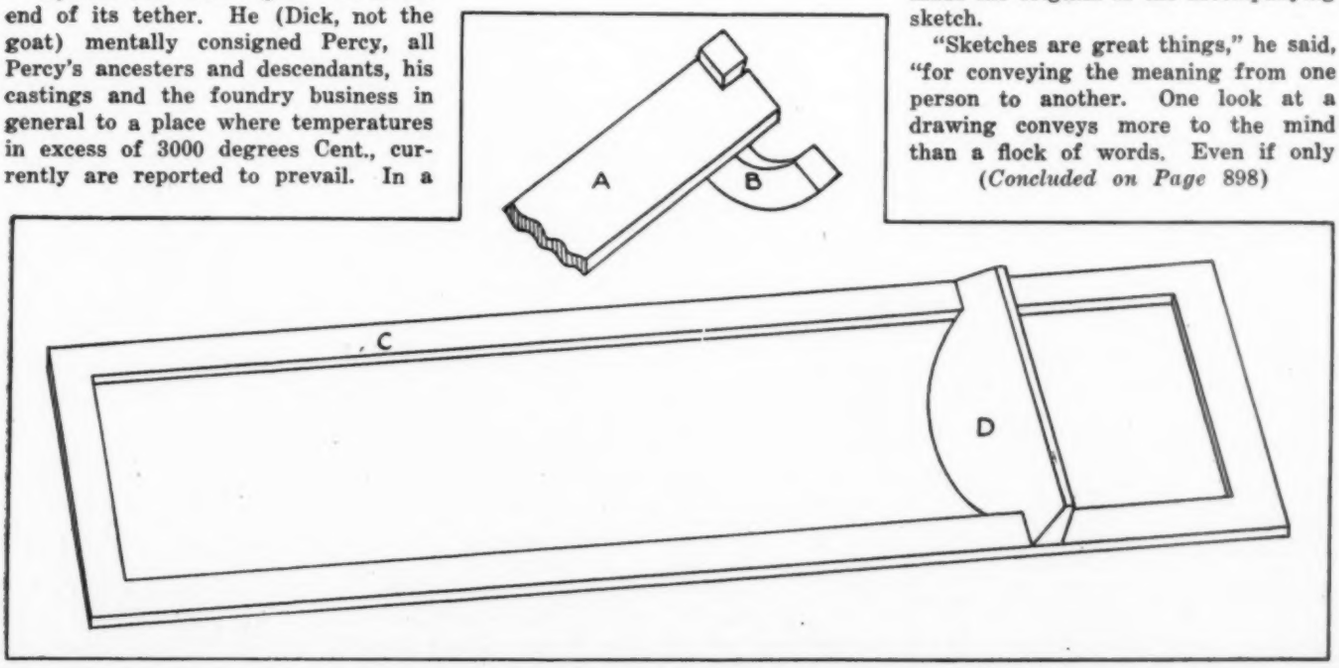


ALTERNATIVE METHODS AND PATTERN DEVICES FOR INCREASING THE DIAMETER OF A MOLD FOR A SLEEVE CASTING

Bureau of Standards Investigates

Rubber Core Binders

This Type of Binder Suggested for Increasing Strength of Green Sand Cores Which Are Air-Dried to Remove Volatile Constituents

IMPERFECT cores are the cause of many bad castings. They often produce blows and cracks and increase cleaning room costs, when it is necessary to remove them from castings with an air hammer or other tools.

It often is necessary to use dry sand cores where green sand cores would be preferable. The United States bureau of standards recently has investigated a new type of core-binder that is different from any other on the market at the present time. If practical the new binder will permit the use of green sand cores over an increased range. The new binders consist of rubber, balata, a material similar to rubber in many of its properties, or special types of rubber cements, known as thermoprenes. Each is dissolved in a suitable solvent, such as gasoline, for plain rubber, and benzol for balata or cements.

The advantages claimed for these binders are that the cores will crush readily, falling to loose sand; will have greater strength than green sand cores, thus extending the range of jobs to which a readily crushable core may be applied; are not oven dried, but are air dried; have a high premeability and remarkable freedom from blowing.

However, there are several disadvantages. Probably the greatest is inflammability. Core rooms using these binders would require special protection to reduce fire hazards. They would have to be exceptionally well ventilated especially around the core benches and free from sparks or flame which might cause fires or explosions. In large installations, the bureau of standards recommends that cores be dried in closed compartments through which a gentle current of air is drawn and the solvent recovered by the usual solvent recovery methods.

Table I

Core Sands To Be Used

Sieve number	Core Sand No. 1	Core Sand No. 2	Core Sand No. 3
6	.....	.....	.....
12	0.2	.....	.....
20	1.5	0.8	.....
40	19.7	8.6	1.6
70	51.8	47.0	13.7
100	14.2	30.8	18.0
140	6.0	7.1	13.7
200	3.0	1.4	13.0
270	1.1	0.3	9.0
Pan	1.6	0.8	31.0
Sand	99.1	96.8	100.0
Clay	0.9	3.2	.....
Permeability with rubber binder 7 per cent by weight	444.0	202.0	32.0
Compressive strength after 24 hours drying, pounds per square inch	10.8	12.2	6.2

Preparing the Binder

Since these core binders possess properties different from any other binder, the choice of sand and core making practice will vary from that generally used. The sand must be free from moisture as this class of binders does not adhere to damp sand. It also must be free, or extremely low in, clay content. If the clay content is not low, the core will be baked hard by the heat of the casting and the work required to disintegrate it would defeat the purpose of the new binders.

The best results need not be expected if the new binders are substituted for others without first ascertaining whether the sand in use is of the proper type to give the benefits of the new binders. Fineness tests of sand which the bureau of standards found suitable are given in Table I.

In preparing the rubber binder, the rubber is cut into small pieces and dissolved in gasoline in the ratio of one pound of rubber to two gallons of gasoline for use in the shop, or ¼ pound of rubber to two quarts of gasoline for experimental purposes. This gives a solution containing approximately 7 per cent rubber by weight. The solution of the rubber must be completed with no clots of undissolved rubber and should be kept in a tightly closed container to prevent evaporation of the solvent.

When ordering rubber specify milled, smoked sheet as vulcanized rubber is insoluble and crude rubber is not satisfactory until it has been kneaded and worked in a suitable apparatus. Gasoline known commercially as aviation gasoline is satisfactory.

The binder may be mixed with dry sand in any suitable type muller or mixer or, experimentally, by hand rubbing. For the sands mentioned in Table I, it was found that 92 parts sand to 8 parts binder was a suitable mix. The mixing must be done with care because of the inflammibility of the gasoline. If the solvent evaporates too rapidly, the binder may be diluted with gasoline before it is used. Sand that is partly dried can be retempered by the addition of gasoline.

When the sand and binder are mixed properly, the mass does not have the stickiness of cement, will rub off the hands readily and will not stick to the coreboxes. The cores may be rammed by any standard method. They will have a higher strength as they come from the corebox than rammed molding sand and much higher than oil sand cores at a similar time. However, the cores must be rodded in the same manner as green sand cores.

Cores made of high permeability sand and not over 1½ inches in diameter lose gasoline so rapidly that they can be placed in the mold without drying. Large cores should be allowed to dry at room temperatures. The rate at which compressive strength develops in a round core 2 inches high and 2 inches in diameter is shown in Table II. This table shows that over half the strength is developed in the first half hour and practically the full strength in 2½ to 3 hours.

If care is taken in the purchase of

(*Concluded on Page* 901)

Table II

Compressive Strength

Time air drying after molding	Rubber binder	Rubber binder plus stiffener
At once	2.5	2.7
½ hour	5.0	5.2
1 hour	5.7	6.65
1½ hours	7.0	8.2
2 hours	7.5	9.1
2½ hours	8.0	10.3
3 hours	8.8	10.5
3½ hours	8.75	11.4
4 hours	9.0	12.5
4½ hours	8.8	12.7
5 hours	9.0	13.7
24 hours	8.1	15.2

Cleaning Room Progress Aids Production of Quality Castings

By Frank G. Steine[illegible]

Part XIV

ONE of the most important problems facing the foundry operator today relates to a reduction in the cost of handling materials in the various foundry processes. While authorities differ on the amount of material which must be handled to produce a ton of good castings, the results of various studies indicate that an enormous amount of handling must be done in foundry work. Naturally, the foundryman is anxious to reduce material handling costs to a minimum so that the keen competition facing the industry today may be met successfully.

Considerable study on the part of equipment manufacturers and foundrymen has resulted in the design and construction of a wide variety of handling equipment which is applicable to every department of the modern casting shop. The installation and use of the various aids to moving and handling materials have made more attractive the conditions under which foundry workers must labor. The *tempo* of production has been speeded, resulting in an increased output with a decrease in the necessary manpower.

The foundry cleaning room presents a variety of problems in materials handling. First, the type of product produced in the plant influences greatly the design of the equipment installed. The layout for a plant specializing in heavy machinery is entirely different from one making smaller castings. Again, the equipment required for a production shop varies greatly from that which will be used in a jobbing shop pouring many different kinds of castings. Before deciding upon the type of handling equipment to be used in a shop, a careful study should be made of

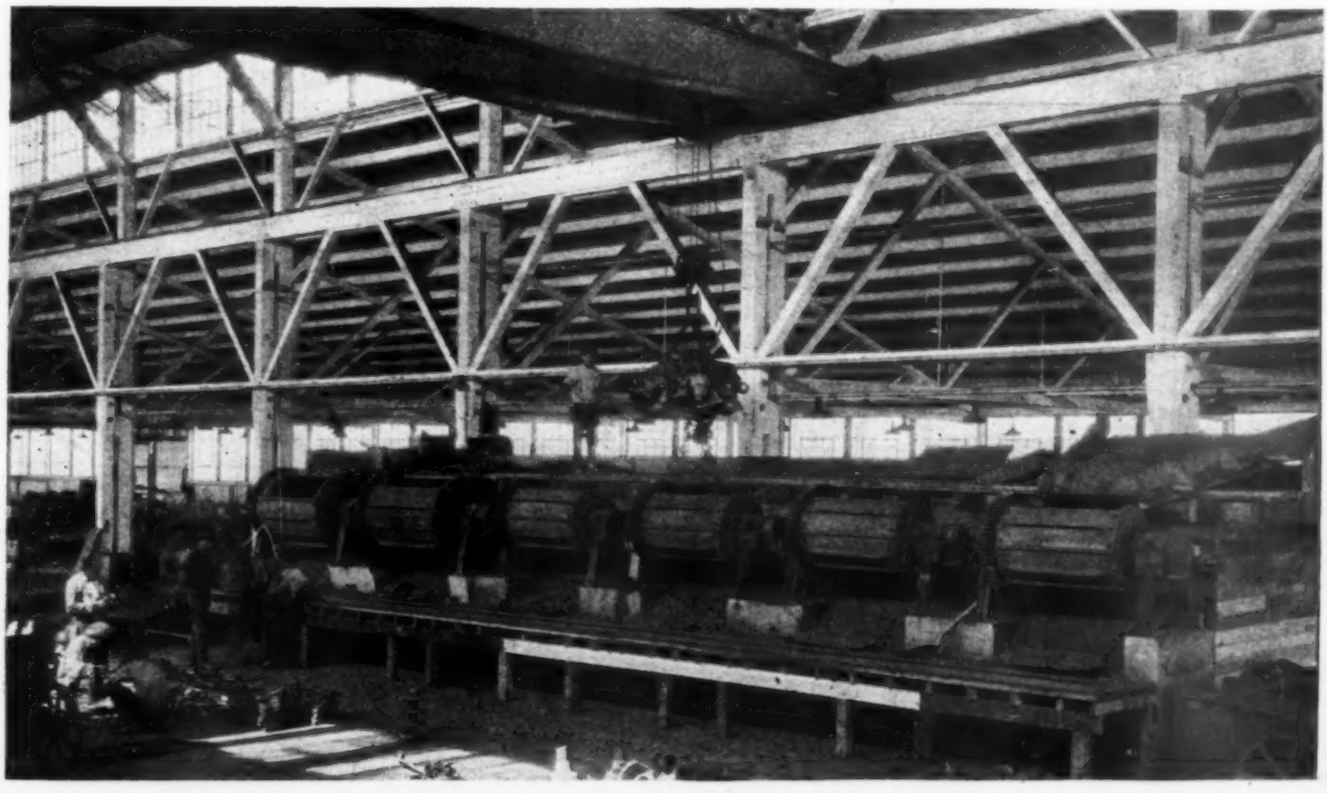


FIG. 104—AN ELECTRIC TRAVELING CRANE EQUIPPED WITH AN ELECTRIC MAGNET IS USED TO LOAD THE CASTINGS INTO A BATTERY OF TUMBLING BARRELS

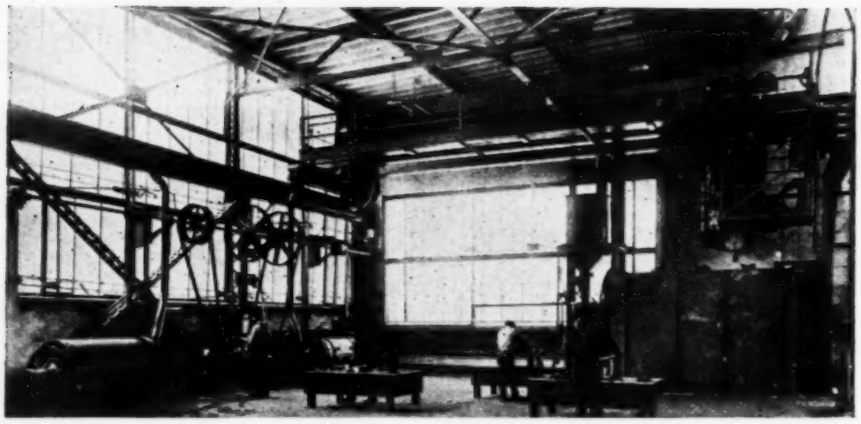


FIG. 105—CONTROLS FOR THE ELECTRIC TRAVELING CRANE USUALLY ARE PLACED IN A CAB SUSPENDED FROM THE BRIDGE

methods and cleaning room equipment. Included in the handling equipment now used in foundry cleaning rooms are the following: Cranes, hoists, monorail systems, gravity conveyors, apron conveyors, power conveyors, industrial trucks, trailer trucks, wheelbarrows, tote boxes, barrels, and equipment for loading sandblast barrels. These various types of equipment will be discussed more or less in detail.

Since a large number of foundries employ cranes in numerous capacities throughout the departments of the foundry to handle materials quickly and efficiently, it is natural that that class of equipment also should become an important factor in moving castings in the cleaning department. Cranes are used to transport large castings and containers holding smaller castings from the shakout to the cleaning department, to move the castings during the cleaning processes and to carry the castings from the cleaning room to the shipping department. Cranes used for these purposes consist usually of an overhead traveling unit, either hand or power operated, or one of several types of jib cranes.

The overhead traveling crane is built in varying designs ranging from a single girder of relatively short span and equipped with a hand operated hoist, to a multiple girder crane capable of lifting several hundred tons. Several types of overhead cranes are shown in the accompanying illustrations. The electric traveling crane consists of a motor operated bridge or girder formed of one or more beams, channels or fabricated structures. This bridge travels forward and back along a runway secured to the building, the speed of travel being determined by the service for which it is designed. Practically all cranes of this type are designed with a factor of safety of not less than five for the rated load. The bridge must be designed to meet the load stress and in addition the transverse strain due to the sudden starting and stopping. Foot-walks with hand rails usually are built on the bridge to permit safe and easy access to the various parts of the bridge for inspection and maintenance. Structural material on crane bridges is designed to meet the standards of the American Society for Testing Materials.

Use Two Web Plates

Since the box girder bridge is used extensively in the foundry and frequently in the cleaning room, the general construction features of that type of equipment will be described. Each girder is built up of two web plates reinforced at frequent intervals by diaphragms or stiffeners riveted between the webs. The plates forming the top and bottom of the box section are riveted to angle bars at the side of the girder. The trolley travels on steel rails fastened securely to the top of the girders, with steel stops provided to prevent overtravel of the trolley. Several manufacturers notch the girders where they fit over the end trucks. The girder is connected to the end truck by angles and heavy gusset plates. The angles are bolted to the top and sides of the truck and the large and heavy gusset plates extend from the bottom of the truck well under the girders. This construction is used to permit the trucks to be held square with the girders, thus reducing excessive truck wheel wear or flange breakage.

The end trucks usually are constructed of a structural steel box section with heavy, cast-steel, axle brackets riveted securely to both webs of the truck frame. Bearing strips on the axle brackets are machined carefully before being riveted to the end truck channels. This permits the bearing strips to carry the weight, thus relieving the rivets of the strain. Where the crane is designed for heavy duty, the end truck may be constructed of a cast-steel frame to provide the necessary strength. Chilled, cast iron or cast steel wheels are used, the number depending on the capacity of the crane. Master Car Builders type bearings are used by a number of crane manufacturers.

On the electric-type cranes, the crane bridge is driven by an electric motor through the squaring shaft and gears mounted on the truck wheels. The electric motor usually is located in the center of the span and is mounted rigidly to the girder.

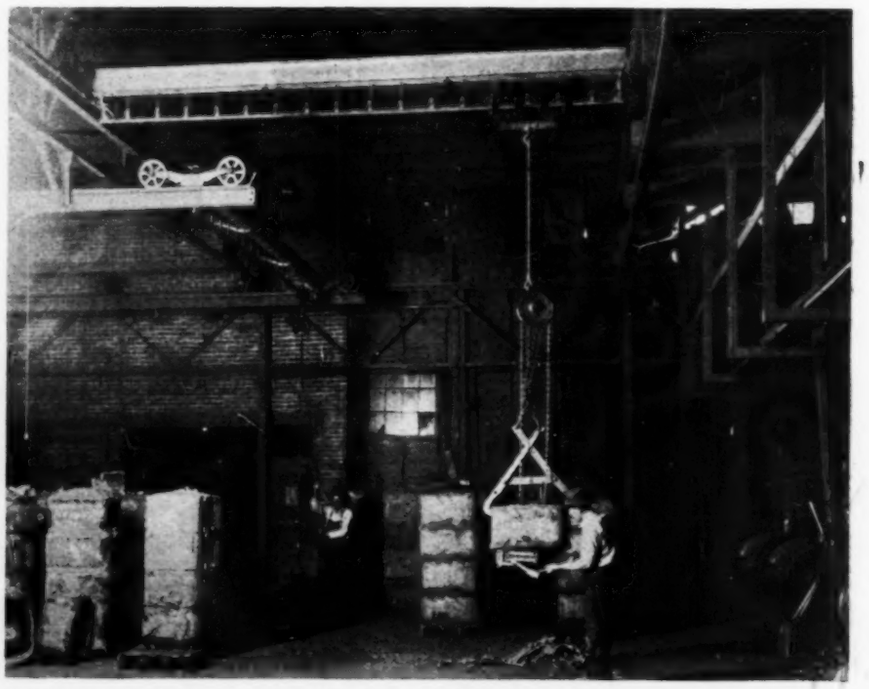


FIG. 106—INTERESTING APPLICATION OF A MONORAIL SYSTEM BUILT ON A SINGLE GIRDER TYPE TRAVELING CRANE

The squaring shaft is supported by brackets located at intervals along the girder. The speed of travel of the bridge is governed by service for which the crane is designed. The driving motor is equipped with a mechanically operated brake which is operated by a foot lever mounted in the operator's cage.

The crane trolley used depends completely upon the service required. The trolley truck of the electric traveling crane usually travels over the track located at the top of the girder section. The truck is driven by an electric motor mounted on the truck and controlled from the operator's cab. The hoisting mechanism built on the gears consists of one or more hoisting drums and trains of gears which are operated by one or more motors also located on the truck and are controlled from the cab. Due to the wide variety of trolleys which are used, it is impossible to discuss the details of construction in this article.

In addition to the electric type traveling crane, numerous types of hand-power traveling cranes are being used in the foundry cleaning room. Machines of this type are used particularly where loads are light, probably not exceeding 5 tons. In this type of crane the bridge usually is constructed of a single I-beam, a double I-beam or a box girder. The single I-beam girder is bolted to cast iron or fabricated steel end trucks and where the head room is limited, the girder may underslung. The latter type of construction is used in installations where the trolley not only is used on the crane girder, but also may be moved to various parts of the plant over stationary monorail when the crane is spotted in the proper place. Another type of single I-beam type crane is illustrated in Fig. 106. Here the monorail track is suspended by hangers from the bottom of the I-beam. In this case the trolley not only operates over the length of the crane, but over the stationary monorail as well. In the crane shown in Fig. 106, a chain hoist is used to lift the load. Application of the hoist to cleaning room problems will be discussed in a later article.

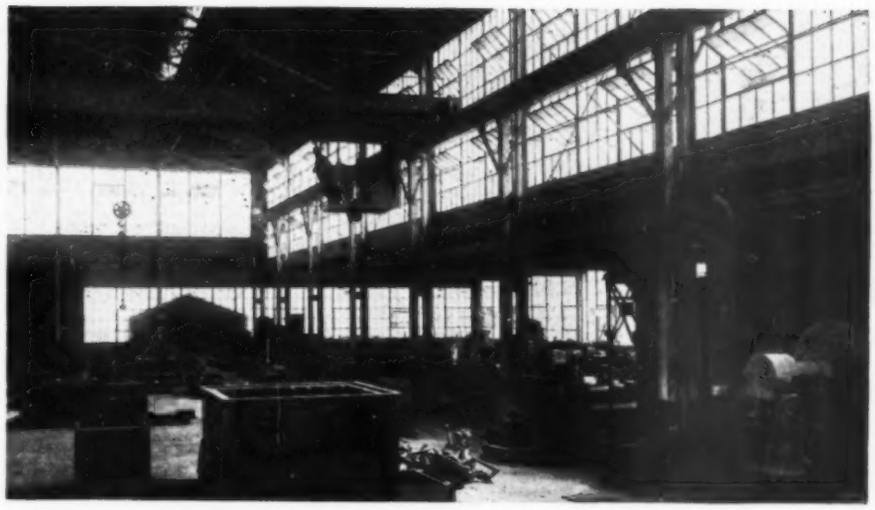


FIG. 108—THE TRAVELING CRANE MAY BE USED TO CARRY THE CASTINGS DIRECT FROM THE FOUNDRY FLOOR TO THE CLEANING DEPARTMENT

Rails Mounted on I-Beams

On the double I-beam type, the girder sections are bolted to cast iron or fabricated steel ends. The trolley usually is a carriage or truck mounted on wheels and traveling over rails mounted on the I-beam sections. The trolleys are equipped with the hoisting mechanism usually operated from the floor by an endless chain. Transverse movement of the trolley also is controlled from the floor. In some types of trolleys, only the transverse movement of the trolley is operated by the chains, while the lifting action is accomplished by an ordinary chain block.

Several types of cranes operated by compressed air and controlled from the floor also are employed in handling materials in the cleaning room. In a completely equipped crane of this type the movement of the bridge, the movement of the trolley and the hoisting action all are controlled pneumatically. In other types the movement of the bridge and the trolley are controlled by hand and the power for hoisting is secured through compressed air.

Numerous types of jib cranes also are used in the foundry cleaning department, several being shown in Fig. 107. Here again, service conditions govern the design of the crane. Often the jib crane consists of a jib or boom which is supported in the horizontal position by a structural member which extends from the outer end of the jib to a point near the bottom of the vertical member. Both the jib and the supporting bar are pivoted to permit rotary motion of the unit. The unit may have a trolley which is supported by the jib and carries the hoisting mechanism, or it may have a chain hoist, air hoist or electric hoist attached near the outer end of the jib. The jibs shown in Fig. 107 are attached to the steel supports of the building. A small trolley rests on the under side of the channel jib beam and this trolley supports the lifting mechanism, which in this case is a pneumatic hoist. The jib supporting member is constructed in the shape of a *Y* to per-

(*Concluded on Page* 898)

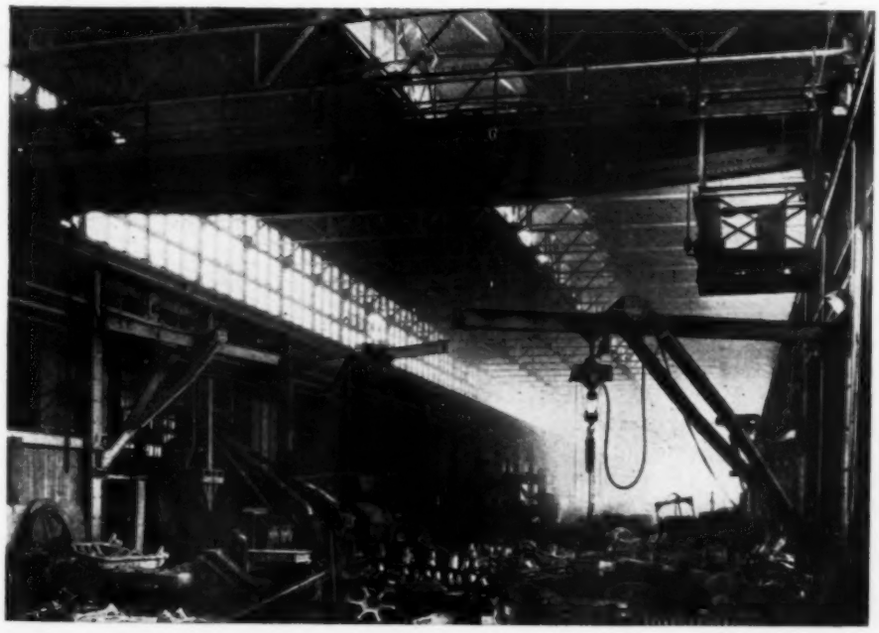


FIG. 107—BOX GIRDER BRIDGE TRAVELING CRANE AND A NUMBER OF JIB CRANES IN A FOUNDRY CLEANING ROOM

Simplify Pattern Work

Through

DESIGN AND CONSTRUCTION CHANGES

By P. D. Forbes

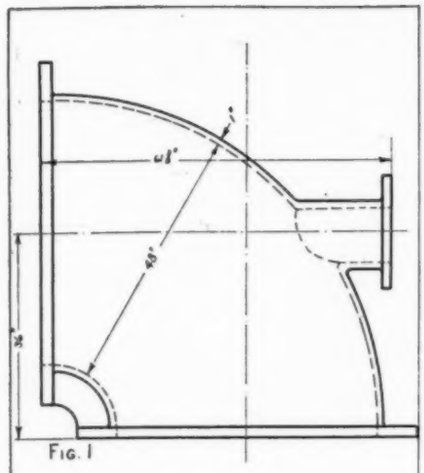


FIG. 1

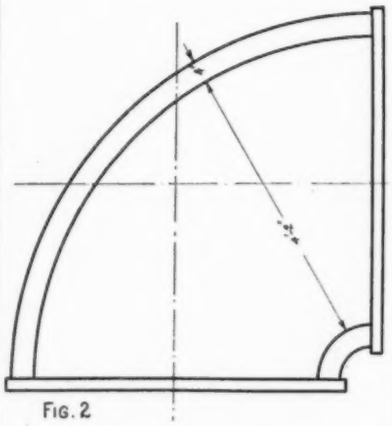


FIG. 2

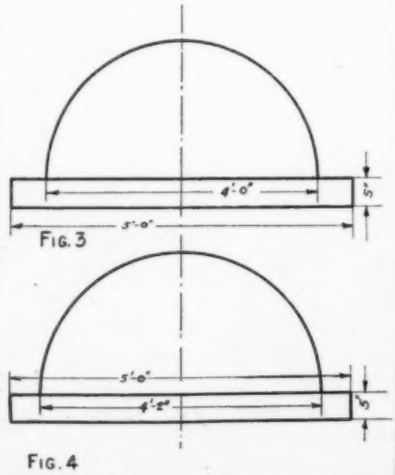


FIG. 3

FIG. 4

SOME jobbing pattern shops turn out splendid patterns both from a molding and a woodworking viewpoint, while others turn out patterns that are useless or nearly useless for the purpose for which they were intended. Many of these patterns have to be re-made entirely before the molder can use them. Others are changed to such an extent that the original patternmaker would not recognize them. A recent example of this kind was a set of coreboxes for a high pressure marine engine cylinder. They were made in record time and were reasonably close to dimensions, but they were of no use to the coremaker.

An outside shop made a pattern for the section of a water wheel case shown in Fig. 1. The pattern and corebox were nice examples of wood working and might have been utilized in making the right and left hand castings required. The foundryman decided he could save time and money by providing a plain frame and a few sweeps as shown in Figs. 2, 3 and 4. The branch was attached separately and is not shown. With this rig the pattern made its own core all in one piece and thus avoided the awkward job of rolling, matching and pasting dry sand cores. Also a nicer fit and a more uniform metal thickness was insured with a self-made green sand core.

Sketch of a gas fan runner is shown in plan and elevation respectively in Figs. 5 and 6. The original pattern arrived at the foundry split through the line *AB*. In the interest of safety and economy the foundryman had a new pattern made solid with a coreprint as shown by the dotted line around the hub. A set of cores from a segment corebox covered the hub and filled the space. This pattern was much more solid and substantial than the other and the mold was made much more quickly and simply.

The core Fig. 9, first was made in two pieces and assembled before it was placed in the liner Fig. 7. Later a new corebox was made in which

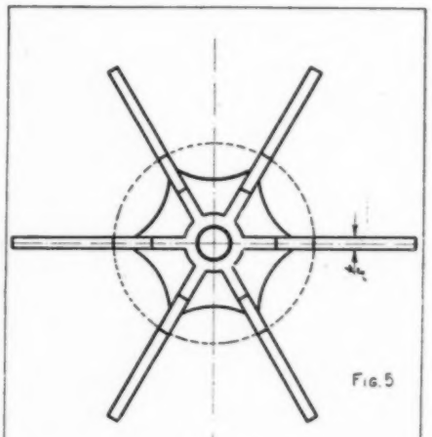


FIG. 5

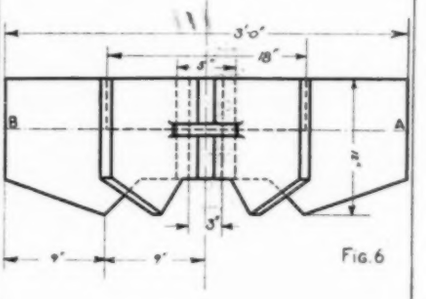


FIG. 6

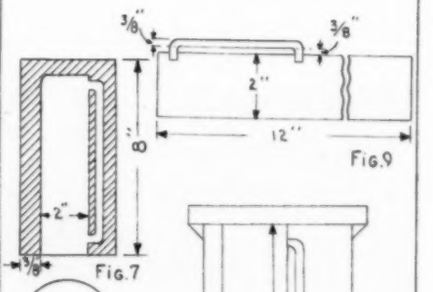


FIG. 9

FIG. 7

FIG. 8

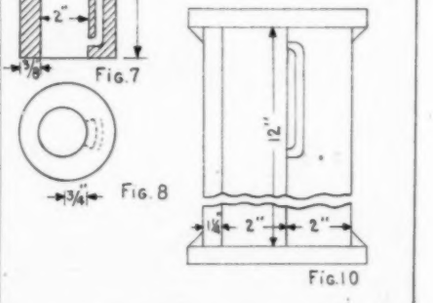


FIG. 10

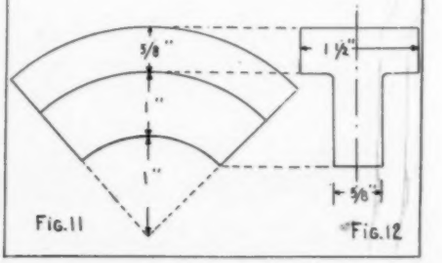


FIG. 11

FIG. 12

the small oil passage member was formed integral with the main body. Two views of a small core required in large quantities are shown in Figs. 11 and 12. At first the corebox was made as a unit with the arc side open. Later it was decided to split the box through the center as indicated by the dotted line in Fig. 12, make the cores in halves and paste them. This method proved much more satisfactory than the first.

Heavy Boiler Sections Made in Production

(*Concluded from Page* 884)

sary small holes have been drilled and tapped.

From the drilling and tapping machines, the sections pass to the reaming department where the large water openings are reamed to the correct size. These openings have a slight taper, and must be reamed accurately to size so that when the connecting nipples are put between two adjoining sections and the sections drawn up, no leakage takes place. A view of one of the smaller reaming machines is shown in Fig. 22. This machine is automatic in operation, and reams three openings at once. The operator places a section in the machine and starts it. The reamers then advance into the openings, and when they have reached the proper depth, the machine automatically reverses and withdraws the reamers from the openings. The operator then removes the section to the short section of roller conveyor at the left, and places another section in the machine. The openings are tested with plug gages by an inspector who passes them or rejects them. Rejections are few because if the casting does not pass inspection, the machine is adjusted at once so that it performs the reaming operation to meet specifications.

This is the third of a series of four articles on the Bond plant, American Radiator Co., Buffalo. The concluding article will appear in an early issue.

Elect Officers

Ralph K. Weber has been elected president of the Mt. Vernon Car Mfg. Co., Mt. Vernon, Ill., to succeed Walter C. Arthurs, who died Sept. 16, and who was president of the company for the past 20 years. H. H. Cust was elected vice president.

R. E. Gersbacher has been appointed assistant sales manager in charge of automotive sales of the Columbus-McKinnon Chain Co., Tonawanda, N. Y.

Group Publishes Booklet

The Electric Steel Founders Research group, which is composed of Fort Pitt Steel Casting Co., McKeesport, Pa., Lebanon Steel Foundry, Lebanon, Pa., Michigan Steel Casting Co., Detroit, Mich., The Nugent Steel Castings Co., Chicago, Ill. and Sivyer Steel Casting Co., Milwaukee, Wis., has published a 31-page booklet giving a short history of the group and presenting also the American Society for Testing Materials specifications for steel castings. The booklet was prepared for distribution at the tenth National Metal Exposition in Philadelphia Oct. 8-12. This group was organized early in 1920 and began its active career on Sept. 1, 1920. The executives and committees of the group include a director, an assistant director, the executive committee, composed of the chief executives of the group companies, the merchandising committee, made up of the sales managers of the co-operating companies, and the sub-committee on research, composed of the research engineers stationed at each of the group plants. The members of this group have adopted certain regulations relative to inspection and specifications which, in their estimation, are of distinct advantage to the purchaser. The offices of the group are 541 Diversey parkway, Chicago. Advice regarding the kind of steel, heat treatment, composition, etc., for industrial applications may be obtained at the group offices free of charge.

Foundries Display Wares

(*Concluded from Page* 880)

ances used in conveying acid liquors or in acid atmospheres and made from acid-resisting material by the Duriron Co., Dayton, O. were displayed at this company's booth. The exhibit included tank outlets; plug and gate valves; a pump connected for belt drive; an ejector; split, flanged, bell and spigot pipe; a sink outlet with strainers; an exhaust fan connected with a motor; etching trays; gage glass fittings; pickling baskets; rods, bolts, nuts, washers, etc.; and a circulating steam jet.

A miscellaneous assortment of heat treating equipment was shown at the booth of the Chicago Steel Foundry Co., Chicago. Included in this exhibit were carburizing boxes, grids and pusher plates; salt, lead and cyanide pots; furnace parts, retorts, camshaft annealing tubes, oil burner parts, chain, and, miscellaneous heat-resisting castings.

One of the features at the exhibit of the Southern Manganese Steel Co., St. Louis was a noncooled shaft and disks for a normalizing and annealing furnace. The company also showed carburizing pots and castings for enameling and roaster furnaces, oil burners, oil cracking still, etc.; and, an assortment of heat and corrosion resistant alloys in the chrome-nickel series.

Alloy castings such as grids, retorts, cyanide and lead pots and other heat treating equipment; castings used in furnace construction; heating machines; and, oil burners were displayed by the Electro Alloys Co., Elyria, O. Samples of die castings, polished and plated to disclose the application of this art and various assemblies of die castings used in the metalworking industries such as fractional horsepower motors, drink mixing machines, bearings, pulleys, radiator caps, etc., were shown at the booth of the Milwaukee Die Casting Co., Milwaukee. Millbury Steel Foundry Co., Millbury, Mass. displayed various type castings including pinions, a large tee, wheels, hot air registers, etc.

Gives Equipment Orders

The index of gross orders for foundry equipment in September was 170.0 as compared with 278.0 in August, according to a recent report of the Foundry Equipment Manufacturers association. The index of shipments in September was 129.7 as compared with 154.1 in August. Unfilled orders gained from 467.2 in August to 529.5 in September. The base is the average monthly shipments for the years 1922-23-24. Comparisons of monthly orders as presented by the association follow:

	1924	1925	1926	1927	1928
Jan.	141.8	104.2	168.2	180.4	132.7
Feb.	121.0	108.8	154.9	198.0	123.6
March	121.9	159.3	157.3	131.1	138.6
April	146.8	124.3	113.2	130.0	107.7
May	108.0	113.3	128.5	134.8	335.6
June	96.4	110.5	133.5	138.4	149.1
July	62.8	117.0	127.3	89.9	94.8
Aug.	77.5	190.0	141.2	106.4	278.0
Sept.	66.0	94.2	114.0	80.4	170.0
Oct.	85.5	149.5	140.5	98.0	.....
Nov.	91.4	180.3	133.4	95.8	.....
Dec.	137.8	140.1	181.0	106.8	.....

Receives Appointment

George F. Joyce has been appointed assistant sales manager for the Magnetic Mfg. Co., Milwaukee. Mr. Joyce is assigned to the Chicago office of the company, which recently moved into larger quarters at 720 Cass street.

L. S. Putman has been placed in charge of the new Denver office of the United States Electrical Tool Co., Cincinnati, located at 1641 Stout street, Denver.

Discuss Safety Factors in Foundries

The seventeenth annual meeting of the National Safety council, which was held in New York, Oct. 1-5 inclusive, surpassed all previous records for the gatherings of this society. One hundred and ten meetings were held in which over 300 papers were presented. The registration at the congress was nearly 3000, but it was estimated that the total attendance exceeded 7000.

An exhibit of safety devices and products identified with safety work which occupied the entire top floor of the Pennsylvania hotel was held in connection with the congress. Included in the exhibit, were various types of clothing, goggles for use in foundries and metalworking establishments, many types of machine guards, safety devices for electrical apparatus and equipment for first aid and resuscitation.

The metals section of the council met at the Waldorf-Astoria hotel Oct. 1, immediately following the general meeting of delegates at the roll call luncheon. J. A. Voss, director of safety and compensation, Central Alloy Steel Co., Massillon, O., and Michael P. Grady, foreman, Pennsylvania railroad shops, Stanton, O., presented a dialog in which nearly all of the usual complaints of foremen with regard to safety were brought up and answered.

Dr. L. W. Chaney, bureau of labor statistics, Washington, presented a paper in which he states, that from the view of safety, the situation in small foundries throughout the country is disappointing. One of the big questions before the metals section is how to reach the small foundry with a comprehensive safety program. In many of these plants, accidents are relatively infrequent, but on a basis of man hours of exposure, they are higher than in any other branch of industry.

Taking foundries as a whole, Dr. Chaney finds that the frequency of accidents has not declined at all in a period of 15 years. In view of the marked decline in frequency of accidents in other industries, this is a startling revelation. However, the severity of accidents among foundries has decreased.

In view of this situation, F. G. Bennett, Buckeye Steel Castings Co., Columbus, O., moved and it was voted that a special committee on foundries be appointed by the executive committee of the metals section to investigate the situation and to devote its energies during the coming year to the solution of the problem.

The small number of representatives of small foundries in the National Safety council was commented upon by Mr. Spengle, National Tube Co., Ellwood City, Pa. Considerable discussion concerning insurance rates for foundries producing small castings as compared to those producing large castings was brought forward. Several speakers urged lower rates for foundries turning out light work and an insurance representative present said he thought that this was a fair request.

A paper by L. A. Hartley, director, educational department, National Founders' association, which was read by F. G. Bennett in the authors absence, advises against rewards unless carefully and unostentatiously presented. Nelson H. Kyser, safety engineer, Studebaker Corp. of America, South Bend, Ind., presented a paper which deals with the methods used in correcting unsafe practices in foundries.

At the Oct. 3, business session Henry A. Reninger, special representative, Lehigh Portland Cement Co., Allentown, Pa., was elected president to succeed Homer E. Niesz, manager industrial relations, Commonwealth Edison Co., Chicago. E. G. Quesnel, Commonwealth Steel Co., Granite City, Ill., was elected chairman of the metals section.

Bill Hears of Queer Doings in Foundry

(*Concluded from Page* 891)

part of a job is shown the mind easily can fill in the remainder. For instance, the upper part of the sketch shows the method that was applied. Only one flange and one end of the strike are shown, but any person who ever worked in a foundry easily can visualize the other end which is the same as the end shown.

"The lower sketch illustrates another style of equipment used on jobs of the character outlined. Under certain conditions it is more accurate than the upper and for that reason is preferred in instances where the foreman does not care to lean too heavily on the workman's care and skill. A rectangular wood frame conforming inside to the required outside diameter of the casting is placed flat on the joint face of the mold and anchored either by driving spikes through suitable holes, or, by placing pieces of pig metal or other weights on it at various points. The strike marked *D* then is drawn backward and forward to remove the desired thickness of sand from the face of the mold. Each half of the mold is treated in the same manner."

Cleaning Room Progress Aids Production

(*Concluded from Page* 895)

mit the hoist to lift a load at practically any point over the full length of the jib.

Each of the various types of cranes is adapted especially to a particular class of material handling work. Where the large electric traveling cranes are used, the hook may be used to handle large castings. Where it is desirable to handle smaller castings with the same type of crane, an electric magnet may be used, as shown in Fig. 104. Here the castings are being picked up from the pile near the shakeout and dropped into the tumbling barrel. The crane also may be used to carry burned molding and other refuse, which may collect in the cleaning room, to a point where it may be transported to the dump. A single line bucket suspended from the hook may be used for this purpose.

Special attention is paid to protecting the various parts of the foundry crane from dust and dirt which may be present. Special dust guards and capped bearings are used and in some cases the bearings are equipped with a method of forced lubrication.

This is the fourteenth of a series of articles describing various types of equipment used in the foundry cleaning room. The fifteenth will appear in an early issue.

Will Re-open Detroit Malleable Shop

McManus Steel & Iron Co., Detroit, has been incorporated to purchase and operate the plant of the Buhl Malleable Co., idle since 1926. This company which was established in 1898 was well known for its malleable products. Patrick J. McManus who is president and manager of the new company was second vice president and manager of the Buhl company from 1909 until its operations were discontinued. Among the directors of the McManus Steel & Iron Co. are the following: W. A. Aubin, secretary-treasurer; Walter T. McManus, vice president; Charles L. Bockus, Studebaker Corp.; Robert S. Drummond, Gear Grinding Machine Co.; David R. Wilson, Wilson foundry Co., Pontiac, Mich.

The new company plans to manufacture steel and malleable castings for automobile and other industries, starting soon after Nov. 1.

Dedicates Laboratory

The new testing laboratory of the American Gas association was officially dedicated recently at Cleveland by Oscar H. Fogg, president of the association. The building is a two story brick structure, erected by the Osborne Engineering Co., providing about 3200 square feet of office space, 8700 square feet of storage space, and 14,700 square feet for appliance testing and research.

This association serves more than 200 makers of gas appliances and has the support of the entire gas industry, the co-operation of the U. S. bureau of mines, U. S. bureau of standards, U. S. public health service, and other interested groups.

Members of the managing committee of the testing laboratory are: R. W. Gallagher, chairman, East Ohio Gas Co., Cleveland; R. M. Conner, American Gas association testing laboratory, Cleveland; J. S. DeHart, Isbell-Porter Co., Newark, N. J.; R. B. Harper, Peoples Gas Light & Coke Co., Chicago; N. T. Sellman, Consolidated Gas Co., New York; G. E. Whitwell, Equitable Gas Co., Pittsburgh.

Detroit Members Visit Wilson Foundry

The Detroit Foundrymen's association introduced an innovation in meeting procedure when more than sixty members from the city of Detroit and nearly twenty from other centers of the district set aside Thursday afternoon and evening, Oct. 18, to be the guests of the Wilson Foundry & Machine Co., Pontiac, Mich. The time from 2:30 until 5 p. m. was devoted to a detailed plant inspection under the guidance of D. R. Wilson, vice president and general manager, Charles E. Wilson, assistant to the manager; Albert Weber, manager of foundries; O. Allan, superintendent F. J. Walls, metallurgist; J. Smith and other executives.

At 6:30 a dinner was served at the Roosevelt hotel where 79 were present. J. J. Boland, Griffin Wheel Co., Detroit, president of the association, presided and introduced Albert Weber who acted as toastmaster. D. R. Wilson, one of the founders of the Wilson company, spoke briefly, tracing the development of the foundry and machine business established only 14 years ago. He acknowledged the influence of the free interchange of information as an aid to industrial development. Mr. Wilson volunteered to supply any information that might be sought by his guests covering the plant, its equipment or any details of operation, offering to provide drawings of machinery if such were needed. Dan M. Avey, editor, THE FOUNDRY, Cleveland, mentioned briefly the phenomenal development of southern Michigan as a foundry center, now consuming some 500,000 tons of pig iron annually in the production of castings.

A. L. Moore, attorney, Pontiac, spoke of the vital need for improved transportation in the coming period when America must look abroad for a market for her tremendous output of manufactured commodities. With the exception of a few European countries whose total purchases of automobiles include 15 per cent from America, the remainder of the world takes from 75 to 97 per cent of its automotive requirements from this country. Mr. Moore advocated immediate action on a deep waterway to tidewater to assist the manufacturer and farmer of the middle west.

Nominate Officers

The American Society for Steel Treating, which held its tenth annual convention and exposition in Philadelphia, Oct. 8-12, nominated the following officers: Dr. Zay Jeffries, consulting engineer and director of the research bureau Aluminum Co. of America, Cleveland, president; R. G. Guthrie, chief metallurgist, Peoples Gas Light & Coke Co., Chicago, vice president; F. T. Sisco, chief of the metallurgical laboratory, United States Air Corps, war department, Wright field, Dayton, O., and A. H. d'Arcambal, metallurgist, Pratt & Whitney Co., Hartford, Conn., directors; and W. H. Eisenman, 7016 Euclid avenue, Cleveland, secretary. Election will be by mail ballot this fall and the new officers will assume their duties in January. Among those remaining on the board of directors is J. M. Watson, metallurgist, Hupp Motor Car Corp., Detroit, and among those retiring is J. Fletcher Harper, research engineer, manufacturing department, Allis-Chalmers Mfg. Co., Milwaukee.

Appoints Agent

Whiting Corp., Harvey, Ill., has appointed the D. S. Mair Machinery Co., Houston, Tex., as its Texas agent. This company will handle the products of the Whiting company and Swenson Evaporator Co., its subsidiary.

D. Walker Wear was elected president of the Stow Mfg. Co. Inc., Binghamton, N. Y. Mr. Wear succeeds Clarence F. Hotchkiss who died recently.

To Promote the Use of Castings

At a meeting of the board of directors of the American Foundrymen's association held in Philadelphia during the annual convention, the general scope of the activities of the association were discussed. The purposes and the medium of accomplishing them were given consideration.

Past-president S. W. Utley, addressing the convention on the general scope of association's activities, pointed out the necessity for a campaign of education to develop knowledge of the use of castings for all work.

The board has approved Mr. Utley's suggestion and has appointed an educational committee consisting of two from each branch of the casting industry; gray iron, malleable, steel and nonferrous, two men from the foundry equipment industry and two men from the foundry supply industry. These men were selected to give national trade associations of these groups full representation on the committee.

The object of the committee will be to dissemenate to engineers and manufacturers information concerning the value of the casting industry, the possible use of castings in manufacturing processes and the many factors which enter into the production of good castings.

Functions of the committee will be purely educational and it will not have as its direct object the merchandising of any particular kind of casting.

The committee is as follows:

GRAY IRON CASTINGS

B. H. Johnson, general manager, Cresson-Morris, Philadelphia.
R. D. Phelps, vice president, Francis & Nygren Foundry Co., Chicago.

MALLEABLE IRON CASTINGS

C. S. Anderson, vice president and general manager, Belle City Malleable Iron Co., Racine, Wis.
D. M. Scott, vice president Symington Co., Rochester, N. Y.

STEEL CASTINGS

Harold S. Falk, vice president and works manager, Falk Corp., Milwaukee.
W. H. Worrilow, president, Lebanon Steel Foundry Co., Lebanon, Pa.

NONFERROUS CASTINGS

N. K. B. Patch, secretary and works manager, Lumen Bearing Co., Buffalo.

FOUNDRY EQUIPMENT

T. S. Hammond, president, Whiting Corp., Harvey, Ill.
A. F. Jensen, president, Hanna Engineering Works, Chicago.

FOUNDRY SUPPLIES

W. J. Cluff, vice president, Frederic B. Stevens, Inc., Detroit.
Werner G. Smith, president, Werner G. Smith Co., Cleveland.

George L. Grimes, 1429 Virginia Ave., Detroit has established the Grimes Molding Machine Sales Co. to handle sales, parts and replacements.

Metals and Melting

How Metallurgical Problems Have Been Solved in Gray Iron, Malleable and Steel

Acid Resisting Iron

Question: I am interested in obtaining information as to the proper analysis of cast iron to withstand the sulphuric acid gas in coal smoke. The casting we want are plates ¼ to ⅜-inch thick.

Answer: Some foundries specialize in making a high-silicon iron ranging as high as 15 per cent in silicon, which resists the action of acid. Otherwise the best analysis of iron for castings to withstand sulphuric acid gas would be one with a low amount of silicon so as to get the combined carbon close to 1 per cent or more. The exact amount of silicon would be determined by the section of the plate and would probably be around 1.25 per cent for the ¼ to ⅜-inch plate. However, this is a matter which would be governed somewhat by your melting practice.

Explains Eutectic

Question—Will you please explain what is meant by the eutectic of a metal or alloy?

Answer—A eutectic alloy is defined as that alloy in a series which has the lowest freezing point of any alloy of the series. The composition of the eutectic alloy is always constant and it always freezes at the same temperature.

An alloy composed of 68 per cent aluminum and 32 per cent copper is the eutectic alloy of aluminum-copper, and an alloy composed of 95.7 per cent iron and 4.3 per cent carbon is the eutectic alloy of iron-carbon.

There may be an excess of either one or both of the constituents that compose the eutectic alloy, but they will freeze out first leaving the eutectic to freeze last.

Publish Many Articles on Heat Treating

Question: We understand that in Oct., 1917 you published an article on the effects of seasoning gray iron castings. Is that article still available or have you published anything along the same line since which you could forward to us.

Answer: The article to which you refer was prepared by L. W. Sherwin at that time with the Brown & Sharpe Manufacturing Co., Providence, R. I., and was presented before the Boston convention of the American Foundrymens association in 1917. It was published in THE FOUNDRY in the Oct. 1917 issue and also appeared in the *Transactions* of the association vol. XXVI of the same year.

Related articles have been published in THE FOUNDRY on several occasions since that time. J. F. Harper and R. S. MacPherran of the Allis-Chalmers Co., West Allis, Wis., presented a paper entitled Effect of Annealing Gray Iron, before the Rochester, N. Y., convention of the A. F. A. This paper was published in THE FOUNDRY, March 1, 1923 and it also is incorporated in the *Transactions* of the association vol. XXX, 1922. An electrically heated oven for heat treating large turbine and other castings at the plant of the General Electric Co., Schenectady, N. Y., was described in the June 1, 1923 issue of THE FOUNDRY.

Method by which motor castings—pistons and sleeves—are heat treated at the plant of the Wilson Foundry & Machine Co., Pontiac, Mich., is described in the Feb. 1, 1923 issue of THE FOUNDRY. We regret that we cannot furnish any of these back numbers of THE FOUNDRY.

For your general information we might say that the practice of heating hard gray iron castings to approximately 1000 degrees Fahr. and then allowing them to cool slowly is practiced to a considerable extent particularly by automobile casting foundries.

Making Radiator Links

Question: I would like information as to the composition of the iron used in radiator castings; the core mixture, and how the cores are removed from the castings.

Answer: Radiator loops are made from an iron containing silicon 2.25 to 2.50 per cent, sulphur below 0.10 per cent, phosphorus between 0.4 and 0.7 per cent and manganese 0.5 to 0.8 per cent. Cores are made with a sharp sand bonded with different oil-base core compounds. The compound, while strong enough to make a firm core, should burn out easily and allow the core to disintegrate when surrounded by the hot iron. The sand is then easily shaken out the nipple holes.

Composition for Warm Air Furnace Castings

Question: Please advise the composition of iron for warm-air furnace castings. These castings will range from 3/16 to ¼-inch in thickness.

Answer: Castings for warm-air furnaces, which are of light section, require an iron high in silicon to insure softness. A large percentage of phosphorus to give it fluidity is desirable, and as sulphur tends to make iron sluggish, it should be kept low. The following composition is satisfactory: Silicon, approximately 2.50 per cent; sulphur, less than 0.1 per cent; phosphorus, 0.5 to 0.9 per cent, and manganese, 0.4 to 0.7 per cent.

Core Oven Temperatures

Question: At what temperature should a core oven be operated to bake oil cores?

Answer: Usually cores are baked at as high a temperature as possible to use without injuring the binder, so that the operation may be as short as possible. This temperature is about 375 degrees Fahr. However, where time is not an important factor cores can be baked satisfactorily at a temperature as low as 240 degrees Fahr. An illustration of this is the oven heated by steam from the waste heat boiler in a malleable iron foundry.

Annealing Gray Iron

Question: Kindly tell us details for the annealing of gray-iron castings.

Answer: Two methods are used for annealing gray iron castings. In the one the castings are heated to about 1000 degrees Fahr. and held at this temperature for an hour or two in order to remove internal strain. Castings which are too hard to machine are annealed at a somewhat high temperature, depending upon the composition of the metal. After being held at the determined temperature for an hour and allowed to cool slowly, the castings should be soft. If the castings are hard after this treatment, the applied temperature was evidently too low and should be raised. However, it should not be taken above 1500 degrees Fahr.

Institute of Metals Holds Meeting

(*Concluded from Page* 874)

The paper describes the peculiar differences in the behavior of Britannia metal under cold rolling and heat treatment, differing from that of most other metals and alloys. Britannia metal primarily is an alloy of tin and antimony. The investigators find that it softens under cold working and hardens under annealing.

O. W. Ellis presented a written discussion of this paper in which he states that he is surprised the work had not been undertaken before. In his own laboratory he found that when Britannia metal is cold worked to give a reduction in section of from 10 to approximately 50 per cent, subsequent annealing produces softening. Annealing after about a 50 per cent reduction in area due to cold rolling has little effect, but after reduction above 50 per cent, annealing produces the hardening effect described in the paper.

A paper not scheduled in the printed program was presented at the Thursday morning session by J. L. Gregg, Western Electric Co., Chicago, on the subject, "Dispersion Hardening in Copper and Silver Base Alloys." Other papers presented Thursday were "Stability of Aluminum and Magnesium Casting Alloys," by A. J. Lyon, first lieutenant, Air Corps. U. S. army, which was read by F. Keller, Aluminum Co. of America, Pittsburgh, and "High Strength in Gold Alloys," by E. M. Wise, research laboratory, International Nickel Co. Inc., New York

Investigates Rubber Core Sand Binders

(*Concluded from Page* 892)

materials and the previously mentioned specifications for sand and solvent are observed, the cores will pour from the castings cleanly without any sign of *burned in* sand. Free pouring of cores occurred in castings made by the bureau of standards from tin, zinc, brass, bronze, phosphor-bronze, aluminum, cast iron, and steel. Although the cores disintegrate readily, they hold their form until the metal freezes and produce castings true to core. There probably is a limit to the size of the core and the mass of metal cast around it in which these binders can be used, but only small cores have been tested.

The addition of stiffeners, such as benzidine and para-amidophenol, to the binders produces a somewhat stronger core. These stiffeners are dissolved in ether and added to the binder in the ratio of ¼ per cent stiffener for each per cent of rubber present. The effect of these stiffeners is shown in Table II.

Other substances of the rubber group, such as guttapercha and balata, may be used as core binders. These materials have the property of softening at temperatures near 100 degrees Fahr. and hardening when cool.

Balata is dissolved in benzol in approximately the same proportions as those given for rubber. When mixed with sand of the proper fineness by any of the standard methods and the solvent evaporated, the unrammed sand does not stick together and can be stored like ordinary sand. When the sand is required for core-making it is heated by hotplates or by some similar method until it becomes plastic. The plasticity is retained to a low temperature and can be hand rammed without discomfort to the workman. The warm sand rams like rubber bonded sand. When the core is cold, it is hard and ready for use.

Balata cores have practically the same strength and properties, as rubber cores, for a given amount of bond, disintegrate well after the metal freezes and give castings true to core. At present the price of balata is nearly twice that of milled smoked rubber. The price of benzol and aviation gasoline is nearly the same.

The thermoprenes are the third class of compounds used in making these binders. These are high-priced, specialized rubber cements. They are used to fasten rubber to metal. This class of compounds has the same physical properties as balata when exposed to heat.

Specifications for sand to be used with the thermoprene binders are the same as those given for rubber binders. These binders are added to the sand and the sand is mixed by the same methods used for rubber binders. After mixing, the sand does not stick to the coreboxes. These binders are mixed with the sand in the proportion of 92 parts of sand to 8 parts binder. This type of binder develops a much stronger core than the rubber binders. Increased amounts of thermoprene binder give increased strength while, under similar circumstances, the rubber binder gives a flexible core.

Sand No. 2, Table I, was used with thermoprene binder in the proportion of 92 parts sand and 8 parts binder and produced a core whose compressive strength was 105 pounds per square inch after air drying for 3 hours and 89.2 pounds per square inch after 24 hours. A similar core, made of 30 parts No. 2 sand, 10 parts No. 1 sand (Table I), 2 parts flour, 1½ parts linseed oil and 6 per cent moisture, baked at 200 degrees Cent. for 1 hour, had a compressive strength of 86.5 pounds per square inch.

By increasing the amount of binder used and adding benzol sufficient after milling to make the mix wet, a core was molded from the mix. The strength was increased to 244.7 pounds per square inch after 5 hours and 286.9 pounds per square inch after 24 hours.

The discovery of the useful properties of rubber and similar materials as core binders is due to C. M. Saeger Jr. The experimental work recorded herein was carried out under his direction largely by C. H. Kerwin and L. D. Jones.

Sells Many Furnaces

Ajax Electrothermic Corp., Trenton, N. J., and its licensees abroad have sold 49 high frequency induction furnaces whose capacities total 3410 kilovolt-amperes. Of this amount, 1223 kilovolt-amperes were sold in this country with Germany the largest foreign buyer. These furnaces are adapted to laboratory and experimental work, production of small amounts of iron or alloys, refining of precious metals, and research work. They have been furnished to many foundries, steel mills, and technical schools throughout the country. Among the users are the Duriron Co., Dayton, O.; Western Electric Co., Chicago; American Rolling Mill Co.; American Car & Foundry Co., Chicago; bureau of mines, Washington; Carnegie Steel Co., Pittsburgh; University of Illinois, Urbana, Ill.

Accepts Position

S. W. Perry, Monmouth, Ill., has joined the sales force of Alexander Milburn Co., Baltimore, and will travel in the middle-western territory. Mr. Perry formerly was associated with the DeVilbiss Co., Toledo, O., and has been identified with the paint spray, automotive, welding and cutting, portable light and engineering equipment fields.

Charles J. Goehringer, formerly president of the Buckeye Products Co., Cincinnati, has returned from an extensive trip to California. Mr. Goehringer now is engaged in selling and dealing in nonferrous metals and alloys under the name of Charles J. Goehringer & Co., Cincinnati.

The Shakeout

DAN M. AVEY, Editor

PAT DWYER, Engineering Editor
FRANK G. STEINEBACH, Associate Editor

CHARLES VICKERS, Nonferrous Editor
EDWIN BREMER, Associate Editor

¶ Safety Pays Dividends

ACCORDING to data compiled by the bureau of labor statistics, Washington, the frequency of accidents in foundries has not declined even a fraction of one per cent during the past 15 years. In view of the decrease in frequency of accidents in other industries in a similar period, this is a sad state of affairs. Is it because foundries are not interested in safety or is it because they have not attacked the safety question with the same zeal that has prevailed in other industries?

The foundries have been slow in adopting safety. To this the foundryman will say, "What do you mean, slow in adopting safety? Don't we have safety guards on the machinery to protect our men and safety bulletins in the shop to instruct them in accident prevention?" This may be true, but the majority of major accidents occur because the injured men fail to observe the rules and lessons in safety set forth in the bulletins.

THE moral is, safety must be taught. The men must be told of the risks that they take in not observing the safety rules and in exposing themselves needlessly to danger. This instruction must be given in a way that will not make them afraid of their jobs, yet will convince them that safety pays. Talks by the safety director or the works manager both to the foremen and to the workmen will pay large dividends by reducing the number of lost time accidents.

A specific case will serve as an illustration. In a certain foundry, guards were used on all parts of the sand handling equipment and the workmen were warned by signs with glaring red letters not to make any adjustments while the machinery was in motion. Regardless of these precautions, one of the workmen on the conveying system removed a guard to make an adjustment. He received injuries from which he died.

WAS this accident due to absolute disobedience, or was it a case of familiarity breeding contempt? Accidents of this type usually occur because the man is so familiar with his job that the risks he takes seem small to him. This is one of the most difficult problems that those in charge of foundry safety must solve. If the man previously mentioned had been schooled properly in safety, the accident probably would not have occurred. A talk on safety might have impressed fear of the risk he was taking. It might have prevented the fatal accident. It would have saved his wife and children the anguish of his death. Further, the company would have saved the cost of hiring and training a man to fill the vacant position and the cost of the compensation.

Educate employes to the fact that safety pays.

¶ Off to a Good Start

FIVE years ago, the exhibiting of castings by co-operating groups or individual plants would have been unprecedented. Whether from shrinking modestly, or due to that habit of underating that with which one is most familiar, foundrymen would have doubted the practical value of such an exhibit. Dating from the Philadelphia convention of the American Foundrymen's association, last spring when an unusually interesting group of steel, malleable and gray iron castings were assembled, the importance of this means of attracting favorable attention from users has had much greater consideration.

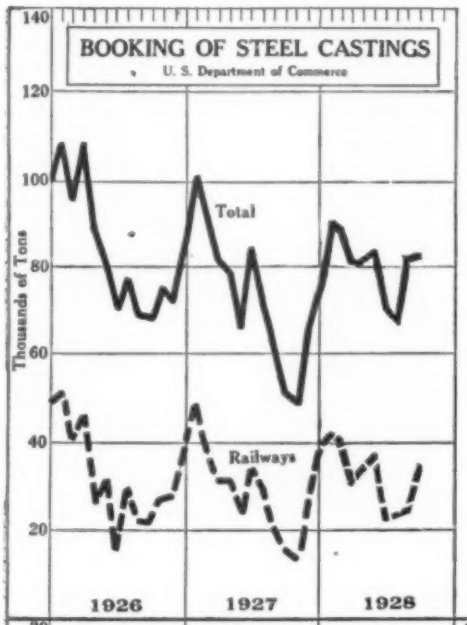
THE recent metals exposition conducted under the direction of the American Society for Steel Treating marked another step forward in this same direction. As will be noted on other pages of this issue of THE FOUNDRY, a number of the leading organizations representing the steel, malleable and gray iron branches of the casting industry took part in this exhibition. In addition, individual companies, many from the divisions indicated and others from nonferrous lines showed castings or equipment tending to demonstrate the service of castings. These exhibitions have served to point the way. More doubtless will follow and will be supplemented by educational effort of all the associations that represent and serve the foundry industry. Such methods should give foundrymen greater respect for their products.

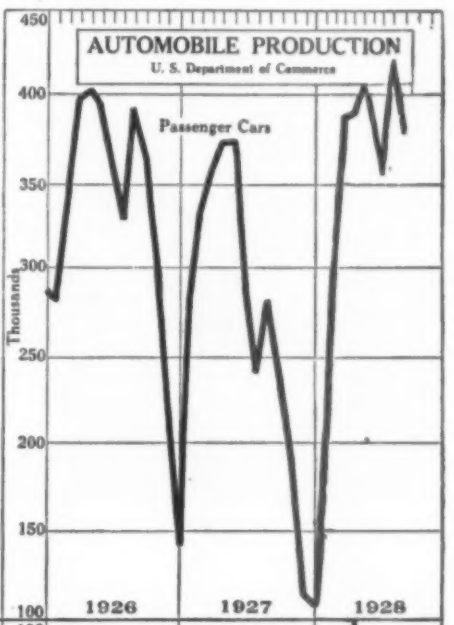
Trade Trends in Tabloid

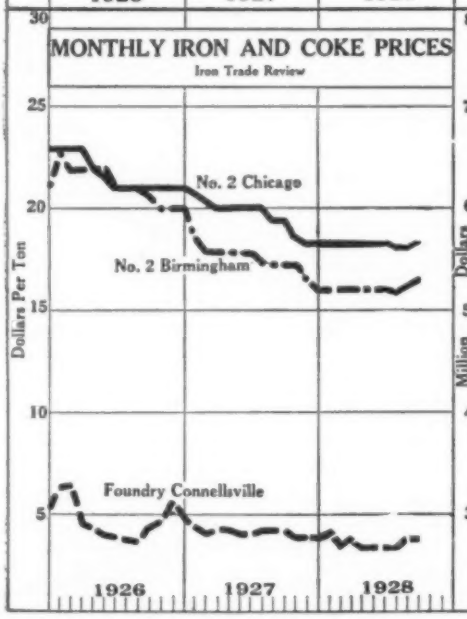
UNIQUE among presidential campaign years, 1928 has been marked by no depression in foundry lines. Jobbing shops and manufacturers' foundries alike have gone through the summer and early fall at a fairly high operating rate. Further, recent reports indicate slightly better prices in gray iron and malleable lines, prices that will show a profit. Automobile production has stepped out to the front as one of the main factors in supporting the 1928 high rate of foundry operation. With the fall months showing a highly satisfactory output, it is expected that the total of all classes of automobiles manufactured this year will exceed 4,600,000 units, more than 100,000 cars ahead of the previous record of 1926. Railways still are buying reluctantly. The total of freight cars awarded in September was greater than the sum of the preceding two months, but still was only 1378, bringing the total for the first eight months to 30,971 as compared with more than 46,000 for the same period last year. Inquiries and orders in early October indicate that the past month will show a gain over September. Steel castings orders for September, according to the department of commerce, showed a gain and now stand at 57 per of capacity. Railway specialty steel castings still are laggard and show 52 per cent of capacity in new orders. Farm equipment manufacturers report this year to be a record breaker.

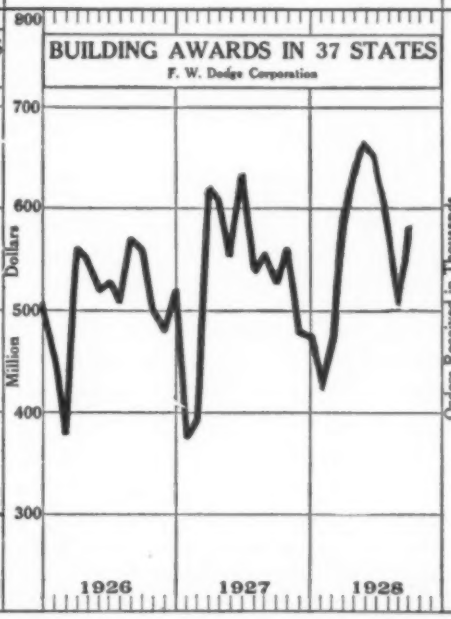
RAW MATERIAL PRICES
Oct. 24, 1928

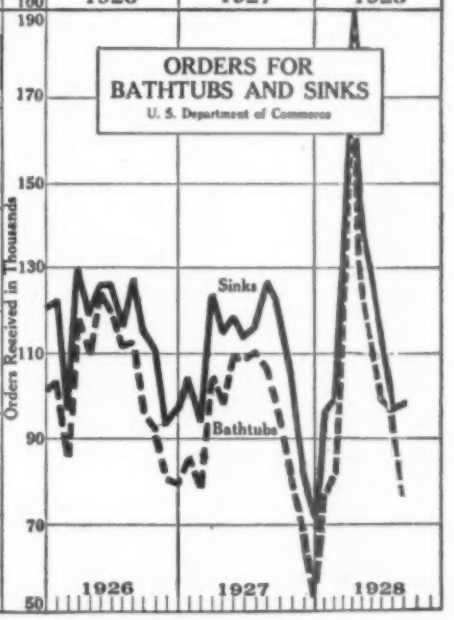
Iron	
No. 2 foundry, Valley	$17.00 to 17.50
No. 2 southern, Birmingham	16.25
No. 2 foundry, Chicago	19.00
No. 2 foundry, Philadelphia	20.76
No. 2 foundry, Buffalo	18.00
Basic, Valley	17.00
Basic, Buffalo	17.00
Malleable, Chicago	19.00
Malleable, Buffalo	18.50
Coke	
Connellsville foundry coke	$3.75 to 4.85
Wise county foundry coke	4.50 to 5.25
Scrap	
Heavy melting steel, Valley	$16.00 to 16.50
Heavy melting steel, Pitts.	17.50 to 18.00
Heavy melting steel, Chicago	14.00 to 14.50
Stove plate, Buffalo	14.25 to 14.75
Stove plate, Chicago	11.50 to 12.00
No. 1 cast, New York	13.00 to 13.50
No. 1 cast, Chicago	14.75 to 15.25
No. 1 cast, Philadelphia	16.50 to 17.00
No. 1 cast, Pittsburgh	14.75 to 15.25
No. 1 cast, Birmingham	14.00 to 14.50
Car wheels, iron Pittsburgh	16.00 to 16.50
Car wheels, iron, Chicago	13.50 to 14.00
Railroad malleable, Chicago	15.25 to 15.75
Agricultural mal., Chicago	13.00 to 13.50
Malleable, Buffalo	15.50 to 16.00
Railroad malleable, Pitts.	14.00 to 14.25
Nonferrous Metals	Cents per pound
Casting, copper, refinery	15.15 to 15.25
Electro, copper, producers	15.50
Straits tin	49.50
Lead, New York	6.50
Antimony, New York	10.87½
Nickel, electro	37.00
Aluminum, No. 12, producers	23.00
Aluminum, No. 12, remelt	15.50 to 16.50
Zinc, East St. Louis, Ill.	6.25











Comings and Goings of Foundrymen

Men of the Industry, Whose Activities Are Making Foundry History

F. HUGHES MOYER has been elected president of the Mackintosh-Hemphill Co., Pittsburgh. He was graduated from Cornell university, Ithaca, N. Y., in 1899 as a mechanical engineer. Mr. Moyer received much of his early training in the foundry and machine shops of the Springfield Architectural Iron Co., Springfield, O. He has held many responsible positions with the Wellman-Seaver-Morgan Co., Cleveland; United States Steel Corp.; Carnegie Steel Co.; Indiana Steel Co.,

F. HUGHES MOYER

now operated by the Illinois Steel Co., a subsidiary of the United States Steel Corp.; Cambria Steel Co., Johnstown, Pa.; Pittsburgh Crucible Steel Co., Midland, Pa.; and the United Alloy Steel Co., Canton, O. Mr. Moyer left the last named company in 1926 to do consulting work and in October of that year was made vice president of the Mackintosh-Hemphill Co. He held that office exactly two years being elected president in October, 1928.

Roy F. Godfrey, for the past 6 years foundry superintendent for the Wright Mfg. Co., Lisbon, O., has resigned. He has accepted a similar position with the Mead-Penn Iron Works Co., Meadville, Pa.

E. C. Felton, formerly assistant to the vice president of the Hunt-Spiller Co., South Boston, has been made assistant treasurer of the company.

A. B. Root, formerly assistant to the vice president of the Hunt-Spiller Co., South Boston, Mass., has been made assistant general manager. He is a past-president of the American Foundrymen's association and of the New England Foundrymen's association and is active in the affairs of the former.

Stuart Wells Utley, past president of the American Foundrymen's association and vice president of the Detroit Steel Casting Co., has been elected president of the Detroit Board of Commerce.

Otis Morgan has resigned as annealer and general labor foreman for the Herschel Mfg. Co., Peoria, Ill., because of ill health.

Charles A. Nickols who has been engineer in charge of construction has been named foundry superintendent of the new plant being built by the Delco-Remy Corp., Anderson, Ind.

D. W. Merriman has been made superintendent of the foundry operated by the Keystone Driller Co., Beaver Falls, Pa.

J. Colip has been made foreman of the Fremont street plant of the Enterprise Foundry Co., San Francisco, manufacturer of iron, brass and steel castings and builder of diesel engines.

William Sutphin has been made foreman of the Buckeye Foundry Co., Cincinnati.

C. W. Russell, vice president and general manager of the Russel Wheel & Foundry Co., Detroit, for a number of years, resigned Oct. 1.

William E. McGraw has resigned his position as general foreman of the Fulton Foundry & Machine Co., Cleveland.

William H. Woodin, Jr., son of the head of the American Car & Foundry Co., and the American Locomotive Co., has been appointed director of research of the first named company. Mr. Woodin acquired his technical training in the Berwick, Pa., plant of the American Car & Foundry Co. His office will be at the executive headquarters of the American Car & Foundry Co., 30 Church street, New York.

Considers Problems

The sectional committee on cast-iron pipe specifications, organized under the sponsorship of the American Water Works association, the New England Water Works association, the American Gas association and the American Society for Testing Materials, is making progress on the many problems before it. Some of these problems are, to arrive at a better basis for the design and thickness of pipe, determining what effects various kinds of trench load conditions have on the stresses in pipes, and determining a method of test for pipes in which the pipes need not be destroyed. This committee also is studying the subject of corro-

WILLIAM H. WOODIN JR.

sion, the various kinds of cement linings for pipe, and also the matter of bituminous coatings. The committee hopes to simplify the fittings in use to eliminate unnecessary duplication and to simplify if possible, the pipes themselves in respect to standard outside diameters and the number of classes in each.

Issues Research Paper

The department of commerce, bureau of standards, has published a research paper on the analysis of bauxite and of refractories of high alumina content. The paper gives the necessary precautions which must be taken both in preparing the sample and in the analysis. An umpire method for the analysis of bauxite and refractories of high alumina content is given in detail, as is also a routine method of analysis.

Officers Are Appointed

As recently announced in THE FOUNDRY, William A. Ready has been made president and Norbert T. Jacobs has been appointed sales manager of the Ames Shovel & Tool Co., North Easton, Mass. Mr. Ready has had a wide experience in manufacturing, engineering and executive work. Previously he was president of the National Co., Malden, Mass., and before that was connected with the United Fruit Co., in the tropics and with Stone & Webster Inc., Boston. He was graduated from the Massachusetts Institute of Technology, Cambridge, Mass. Previous to his appointment as sales manager, Mr. Jacobs was district sales manager of the Detroit Steel Products Co. in charge of the Buffalo office, with a wide experience in sales work.

WILLIAM A. READY

NORBERT T. JACOBS

Obituary

Edward H. Swindell, aged 61, treasurer of William Swindell & Bros., Pittsburgh, and president of the New Castle Refractories Co., and the American Dressler Tunnel Kiln Co., New Castle, Pa., died Oct. 11 at his home in Pittsburgh. He was a graduate of Lafayette college and was a member of the American Iron and Steel institute.

Percy C. Dierdorff, manager of the Cleveland office of the Jeffrey Mfg. Co., Columbus, O., died at his home in Lakewood, O., recently. Prior to becoming manager of the Cleveland office in 1913, Mr. Dierdorff was with the Jeffrey company for 10 years.

Abram James, proprietor of the Pioneer Foundry, LaCrosse, Wis., established in 1856, died recently at the age of 74 years. He was born in England and came to America in 1869, joining his father and brothers in LaCrosse in 1874. After their death Mr. James became the sole owner.

C. Frank Seay, city sales manager for the Mosher Steel & Machinery Co., Dallas, Tex., died recently. He was 42 years old.

Foundry Association Directory

American Foundrymen's Association

President, S. T. JOHNSTON, S. Obermayer Co., Chicago; secretary-treasurer, C. E. HOYT, 222 West Adams street, Chicago; technical secretary, R. E. KENNEDY, 222 West Adams street, Chicago.

Associated Brass Founders of New England

President, J. A. DUNCAN, Wm. Duncan & Sons Co., 166 Liverpool street, East Boston, Mass.; Secretary, LEROY P. ROBINSON, 141 Milk street, Boston. Meeting the fourth Wednesday of each month at the Engineers' club, Boston.

The Buffalo Foundrymen

President, J. MCARTHUR, Washington Iron Works; secretary, W. J. WARK, E. J. Woodison Co., 146 Chandler street. Meetings on third Wednesday of the month at 146 Chandler street.

Central Illinois Foundrymen's Club

President, H. M. HIRE, Hire Foundry Co., Peoria, Ill.; secretary, FRANKLIN WHITEHEAD, The Meadoms Mfg. Co., Bloomington, Ill.

Chicago Foundrymen's Club

President, DAVID G. ANDERSON, Western Electric Co.; secretary, ALBERT N. WALLIN, S. Obermayer Co., 2563 W. Eighteenth street. Meetings second Saturday in each month at the City club, 315 Plymouth court.

Connecticut Foundrymen's Association

President, FRED W. STICKLE, Capitol Foundry Co., Hartford, Conn.; secretary, C. S. NEUMANN, Union Mfg. Co., New Britain, Conn. Meetings are on second Friday of each month in various parts of the state.

Detroit Foundrymen's Association

President, J. J. BOLAND, Griffin Wheel Co., Detroit; secretary, ROBERT HOPE, Holley Carburetor Co., Detroit. Meetings third Thursday in each month at Webster hall, Cass and Putnam avenues, Detroit.

East Bay Foundrymen's Association

Secretary, H. L. MARTIN, Marchant's Foundry Co., 4401 East Tenth street, Oakland, Calif.

Gray Iron Institute

President, WALTER L. SEELBACH, Forest City-Walworth Run Foundries Co., Cleveland; Secretary, ARTHUR J. TUSCANY, Terminal Tower building, Cleveland.

Malleable Iron Research Institute

President, F. L. SIVYER, Rockford-Northwestern Malleable Corp., Rockford, Ill.; secretary, ROBERT E. BELT, Union Trust building, Cleveland.

Metropolitan Brass Founders' Association

President, WILLIAM EMBER, Jefferson Brass Foundry, 62 Delevan street, Brooklyn, N. Y.; secretary, WILLIAM E. PAULSON, Thomas Paulson & Son Inc., 97 Second avenue, Brooklyn, N. Y. Meeting second Wednesday in each month at the Building Trades club, 34 West Thirty-third street, New York.

Newark Foundrymen's Association

President, J. L. CARTER, Barlow Foundry Inc., Newark; secretary, W. H. MANTZ, Atlas Foundry Co., Irvington, N. J. Meeting called by president.

New England Foundrymen's Association

President, CHARLES F. MILLER, Universal Winding Co., Providence, R. I.; secretary, FRED F. STOCKWELL, 205 Broadway, Cambridgeport, Mass. Meetings second Wednesday of each month at the Exchange club, Boston. Outings usually are held in the summer months.

Ohio Foundries Association Inc.

President, C. C. SMITH, Toledo Steel Casting Co., Bancroft and Smead avenue, Toledo, O.; secretary-manager E. F. SCOTT, 5713 Euclid avenue, Cleveland.

Philadelphia Foundrymen's Association

President, WALTER WOOD, R. D. Wood & Co., Philadelphia; secretary HOWARD EVANS, Union League club, Philadelphia. Meetings the second Wednesday of each month at the Manufacturers' club.

Southern Metal Trades Association

President, GEORGE B. COCKER, Gastonia, N. C.; secretary, W. E. DUNN JR., Healy building, Atlanta, Ga.

Pittsburgh Foundrymen's Association

President, W. P. BRADLEY, Wheeling Mold & Foundry Co.; secretary-treasurer WILLIAM J. BRANT, Wm. J. Brant, Bessemer building, Pittsburgh. Meeting on the third Monday of the month, except in July and August, at Fort Pitt hotel.

Quad-City Foundrymen's Association

President, A. D. MATHESON, French & Hecht, Davenport, Iowa; secretary-treasurer, HUGO WOLF, Frank Foundries Corp., Davenport, Iowa. Meetings the third Monday of each month, the meeting place being rotated between Moline, Rock Island and Davenport.

Tri-City Technical Council

Chairman F. V. SKELLEY. Tri-City Railway Co., Rock Island, Ill.; treasurer, MAX SKLOVSKY, Deere & Co., Moline, Ill. Combined meetings held only one or two times a year on call.

Tri-State Foundrymen's Association

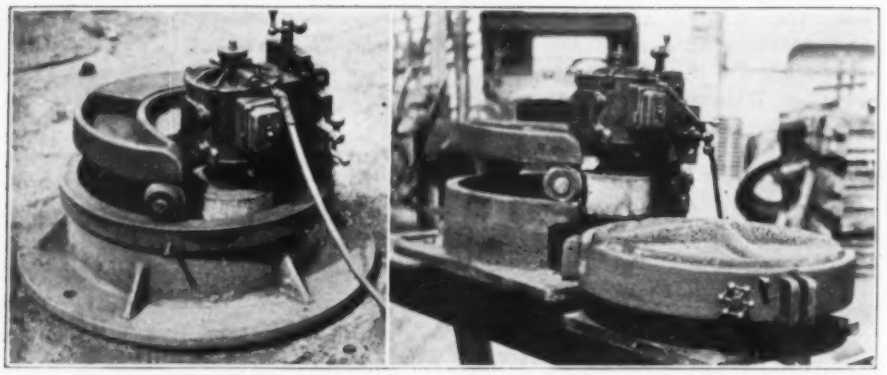
President, HAROLD P. RITTER, John A. Oberhelman Foundry Co., 3323 Colerain avenue; secretary, GEORGE W. PIEHL, Wessling Bros. Foundry Co., 1607 McLean avenue. Meetings the second Thursday of each month at the Cincinnati club, Eighth and Race streets.

Twin City Foundrymen's Association

President, H. H. NOTT, Smith System Heating Co., Minneapolis; secretary-treasurer, C. E. LANGDON, 3849 Lyndale avenue, south, Minneapolis. Meetings monthly at the Athletic club.

Washington Foundrymen's Club

President, RONALD KUCHER, Olympic Foundry Co., Argo Station, Seattle; secretary, EDWARD C. GUSTIN, The Prescott Co., 1 West Lander street, Seattle. Meetings second and fourth Tuesdays of each month at the Elks Temple, Fourth avenue and Spring street.



THE RIG USED TO GRIND RINGS IS SHOWN AT THE LEFT WHILE THE EQUIPMENT FOR SURFACING LIDS IS SHOWN AT THE RIGHT

Surfaces Manhole Rings

An interesting surfacing machine for grinding manhole rings and lids has been introduced by the C. H. Lyne Foundry & Machine Co., 105-109 Northwest Fifth street, Miami, Fla. As may be noted in the accompanying illustration the unit consists of a frame mounted on three wheels and a grinding wheel attached directly to the rotor shaft of an electric motor. The motor and wheel may be raised or lowered by a hand operated feed screw. Lateral motion also may be secured by a second hand operated feed screw. When grinding the manhole ring the entire machine revolves, but when grinding lids the machine is stationary and the lids are revolved on a table, as shown in the accompanying illustration. It is claimed that this machine may be operated by unskilled labor, thus making it unnecessary to use the valuable space in the machine shop to finish that type of work. Using unskilled labor, the manufacturer of this equipment has machined 22 complete sets in a period of nine hours.

Antifriction Bearings Used on Blower

The P. H. & F. M. Roots Co., Connersville, Ind., manufacturers of positive pressure blowers, now is using antifriction bearings for its line of blowers. Standard blowers may be equipped with heavy duty roller bearings made by the Timken Roller Bearing Co., Canton, O., or S K F Industries, Inc., New York, upon the purchaser's specification. Smaller units are equipped with roller or ball bearings upon specification.

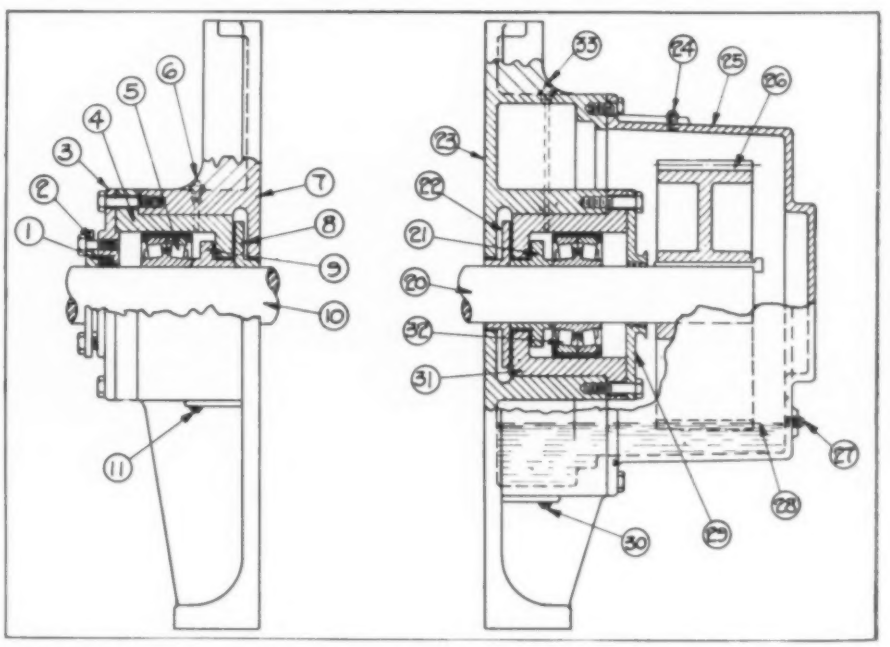
The blower construction also has been redesigned entirely, and changed to allow additional operating advantages. Extreme care has been taken in designing the mounting. Protection from the entrance of foreign substances into the bearing housing has been provided. Space is allowed around the bearing for a sufficient supply of lubricant, and provision is made for forcing the lubricant through the bearing from one side to the other.

In the accompanying illustrations, the drawing at the left shows the driving end headplate. Number 1 indicates the stuffing box packing to retain lubricant in the bearing compartment; 2, the stuffing box packing gland; 3, the bearing mounting cup cover plate; 4, the bearing mounting cup which insures correct alignment and support of bearing, also serving as bearing puller; 5, the heavy duty double row roller bearing of large carrying capacity; 6, the grease gun connection for lubricating bearing; 7, the blower headplate drive end which supports the bearing mounting; 8, the bearing seal flinger ring; 9, the spacing collar; 10, the finished steel impeller shaft; 11, the vent to be opened when charging bearing with lubricant.

The gear end headplate is shown at the right. Number 20 is the finished steel impeller shaft; 21, the placing collar; 22, the bearing seal flinger ring; 23, the blower headplate gear end which supports bearing mounting and carries the finished flange to receive gear housing; 24, the oil filler plug for gear housing; 25, the bowl-type, cast-iron gear housing enclosing timing gears; 26, the timing gears of semisteel accurately cut from solid wide face blanks, operating in a bath of oil; 27, the oil level plug for gear housing so maintained that one-half the gear tooth length is submerged; 29, the bearing mounting cup cover plate; 30, the pipe plug for draining lubricant from gear housing; 31, the bearing mounting cup; 32, the heavy duty double row roller bearing of extremely large carrying capacity; 33, the grease gun connection for lubricating bearing.

Introduces Ring Lining for Crucible Furnaces

The Lava Crucible Co., Pittsburgh, recently has developed a new line of ring linings for crucible melting furnaces. The refractory rings are made in complete circles in diameters to fit any furnace, with the provision being made for the burner opening and slag hole. In constructing a lining for a crucible furnace a special bottom section is used and the walls are made of a series of rings placed one on top of the other to the top of the furnace. The rings are cemented together at the joints with a special high temperature cement, which also is made by the Lava Crucible Co. The action of this cement causes the en-



BEARING FOR THE DRIVING END HEADPLATE IS SHOWN AT THE LEFT AND THE BEARING FOR THE GEAR END HEADPLATE AT THE RIGHT

tire lining to be united into practically one piece.

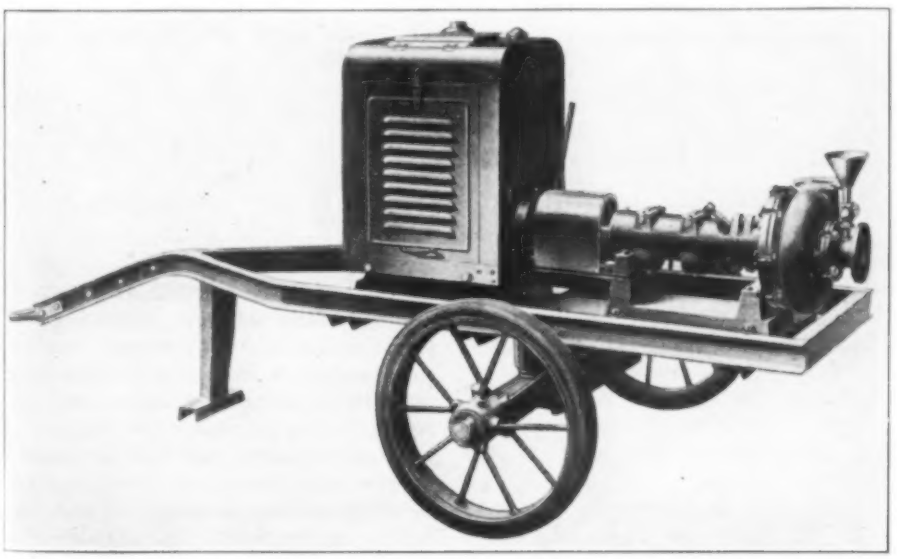
It is claimed that the linings do not slag, and consequently require a minimum of patching or maintenance. It also is stated that since the rings are fired at high temperatures, they offer greater resistance to the cutting action of the flame and to fusion. This feature permits the lining to maintain an even melting zone and provides for uniform temperatures in the furnace. The composition of the cement used in uniting the ring linings of the furnace is such that the unit may be fired immediately after being lined.

While these linings were developed primarily for crucible melting furnaces, the same type of refractory now is made in special shapes for open flame melting furnaces and electric furnaces melting nonferrous metals.

Uses Manganese Steel in Portable Pumps

The American Manganese Steel Co., Chicago Heights, Ill., recently has built a series of pumping units using manganese steel for the shell, impeller and disks where shock, wear and abrasion are present. One of these pumps is shown in the accompanying illustration. A long, ring-oiling, babbitted, sleeve bearing supports the shaft to which the impeller is press-fitted. The entire unit is mounted on a base plate and connected with a flexible coupling through a friction clutch to the power. The frame is made of 3-inch channels upon which the power and pumping units are fastened securely.

The pumps are made with 2-inch, 2½-inch and 3-inch discharge lines and are powered by 6, 8 and 10-horsepower engines respectively. Pumping capacity varies with the size of the unit, the smallest having a capacity of 100 gallons per minute against a 34-foot lift. Overall length of the equipment is 9 feet 6 inches, height 4 feet and width 4 feet 11 inches.



THE ENTIRE UNIT IS MOUNTED ON A BASE PLATE AND CONNECTED WITH A FLEXIBLE COUPLING

THE CRANE HAS A DOUBLE I-BEAM BRIDGE SUPPORTING THE SERVICE TRACKS

Compound Crane Gives Double Service

Modern Pouring Device Co., Port Washington, Wis., recently has designed a compound crane for double crane service on a large span crane bay. As shown in the accompanying illustration, a large box crane spans the entire bay. This crane has a double I-beam bridge, the beams supporting the tracks for the smaller service cranes. It is said to be possible to operate two or three cranes on these tracks independent of one another. The construction is applicable in high speed molding operations in foundries where the speed of transporting the material determines the production. Several crews can work under the compound crane at one time. The handpower cranes are of the small span type and may be handled easily.

Gives Wrong Impression

In the article by J. E. Hurst, "Melting Iron in the Cupola," appearing in the Oct. 1 issue, reference is made on page 794 to a cupola manufactured by the Titgen-Eastwood Co. This cupola formerly was built by the J. W. Paxson Co.

To correct any misapprehension which may exist, the J. W. Paxson Co. was not succeeded by the Titgen-Eastwood Co. The latter bought the patterns and drawings of equipment. The remainder of the business including production of foundry sands, facings and supplies at the former plant of the Paxson company is now handled by Paxson Taggart, Inc., Luzerne and D streets, Philadelphia.

Hold October Meeting

The Pittsburgh Foundrymen's association held its initial meeting of the season, Oct. 15, at the Fort Pitt hotel. The meeting was addressed by John A. Cartel, director of safety bureau, Carnegie Steel Co., Pittsburgh, and past president of the Western Safety council. W. L. Mesta, vice president of the association, presided at the meeting in the absence of President W. P. Bradley.

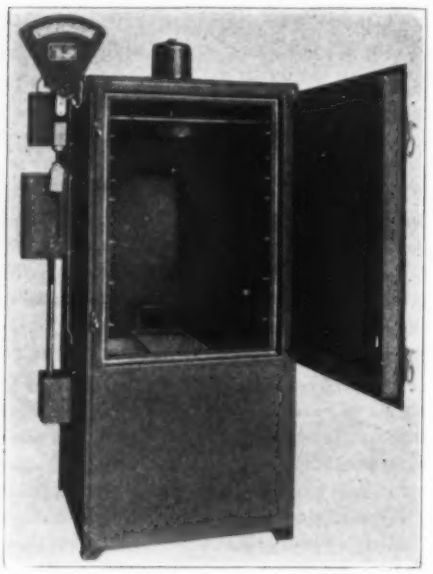
Louis Schlesinger has retired as president of the Bradley Wash-Fountain Co., 2203 Michigan street, Milwaukee. His interest has been taken over by H. A. Mullett and associates. Mr. Mullett becomes president; G. W. Grossenbach, vice president; R. H. Weins, treasurer; and E. S. Wetherell, secretary.

Milwaukee Group Meets

The October meeting of the Milwaukee chapter, American Society for Steel Treating was held in the Colonial room of the Republican hotel Oct. 17. F. B. Coyle, International Nickel Co., New York, gave an illustrated lecture on nickel and chromium in gray cast iron. A special invitation was extended to the Wisconsin Gray Iron Research group, University of Wisconsin and others interested in better cast iron.

Heat Insulation Provided In Laboratory Oven

Young Brothers Co., 6508 Mack avenue, Detroit, has introduced a small oven which may be used to test



THE OVEN MAY BE USED FOR EXPERIMENTAL WORK IN THE FOUNDRY

core binders, sand and other foundry materials. The ovens are built to give temperatures up to 700 degrees Fahr., using electric heat, indirect gas heat, or direct gas heat. The ovens may be equipped with automatic temperature control apparatus or with hand control equipment. As may be noted in the accompanying illustration, a fan agitates the oven air.

Heat insulation is provided within the walls, roof and floor, which contain a 2-inch thickness of insulating material. This type of construction prevents any heat losses, permits operating economy and allows the oven to reach a baking heat quickly when started cold. The doors have the same heat insulation as the oven walls with extra insulation between the lining and door face. A ventilating heater shield protects heaters or gas burners which are located below the floor level. Legs are provided so that the ovens may be located on an ordinary wood floor, bench or table. The shelf angles are adjustable to 3-inch centers. Ventilation is secured through an air inlet in the oven floor and an outlet through the roof vent with collar and damper. For hand control electrically heated ovens, a fused knife switch is used, while for automatic control a panel is supplied.

Lists Standards

The United States bureau of standards is prepared to furnish standard samples, old and new, a list of which has not been published for some time. The history of the samples and their uses are given in the bureau of standards circular No. 25. General information and analysis of the samples are given in the supplement to this circular. These papers may be obtained from the bureau free of charge.

The American Foundrymen's association has special interest in this phase of work of the bureau for it was this society that started the bureau in this field in 1908 when it turned over to the bureau its standard samples of pig iron, the results of the work of a special committee of which the late Thomas D. West, one of the founders of the American Foundrymen's association and a past-president, was chairman.

Consolidate Foundries

General Foundry & Machine Co., Flint, Mich., has been organized to acquire assets of the Flint Foundry Co., General Foundries and the Flint Malleable Castings Co., all of Flint. The Flint Malleable Castings Co. also operates a plant at Marshall, Mich., which will be a part of the new consolidation. In addition to gray iron and malleable castings, the General Foundry & Machine Co. will add finishing shop operations to take care of galvanizing, machining and other finishing. J. M. Barringer is president of the new consolidation.

Points to Progress in Apprentice Training

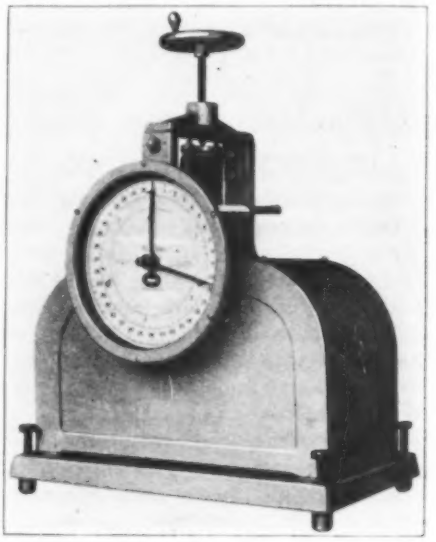
Tri-Cities section of the American Society of Mechanical Engineers met at the Le Claire hotel, Moline, Ill., Oct. 23. S. M. Brah, supervisor of apprentices for the Tri-City Manufacturers association, was the speaker of the evening. Mr. Brah told of the apprentice training program and what had been accomplished since it was started.

R. F. Hutt has been placed in charge of the Minneapolis office of the Van Dorn Electric Tool Co.

Measures Sand Strength

The Federal Foundry Supply Co., Cleveland, recently has introduced a testing machine to determine the strength of either green or dry molding sand and core sand. The American Foundrymen's association permeability sand specimen is used in this test. This specimen is placed on a flat compression plate and then is placed on the scale platform as shown in the accompanying illustration.

Compression is produced by screwing the hand wheel downward. Pressure is registered on the dial in pounds per square inch. The dial is equipped with two indicator hands, both of which move forward when pressure is applied. When the speci-



THE DIAL REGISTERS THE PRESSURE APPLIED

men breaks one indicator hand returns to zero, while the free hand remains at the point where the greatest pressure was applied, until it is returned to zero by the operator. The scale is of the springless type and operates in the same manner as any springless type platform scale. The machine may be checked for accuracy by placing test weights on the scale platform. The scale will register pressures from zero to 36 pounds per square inch.

Issues Glossary

A glossary of the definitions of terms appearing in American Society for Testing Materials standards and tentative standards recently has been issued in mimeograph form under the auspices of committee E-8 on nomenclature and definitions. Members interested in the glossary may obtain copies on request. The glossary is in preliminary form and only a few copies are available.

Plans Annual Meeting of Gray Iron Group

The first annual meeting of the Gray Iron institute will be held Wednesday, Nov. 14, at the Cleveland chamber of commerce, Terminal Tower building, Cleveland. At that meeting reports of officers will be received, directors elected for the ensuing year and certain matters of policy determined.

At the Philadelphia meeting, May 18, directors were elected to serve for a six-month period, the incorporation of the institute was authorized and other steps taken to place the Gray Iron institute on a business basis as a going organization. A number of members have been enrolled and today the organization comprises 70 gray iron foundry companies in various sections of the country.

A nominating committee has been appointed by the board of directors to present nominees for directors. This committee consists of the following: Chhirman, Howard J. O'Neil, Western Foundry Co., Chicago; Paul C. DeWolf, Browne & Sharp Mfg. Co., Providence; David L. Sacks, Louis Sacks Foundry Inc., Newark, N. J.; Harry Cooke, Olney Foundry Co., Philadelphia; William F. Bornfleth, Cream City Foundry Co., Milwaukee.

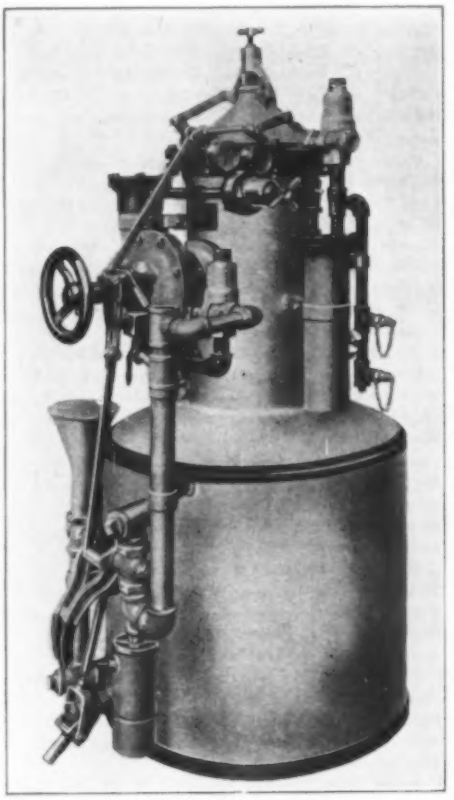
Builds Medium Pressure Acetylene Generator

Three medium-pressure type acetylene generators for welding and cutting recently have been introduced by the Oxweld Acetylene Co., 30 East Forty-second street, New York. The medium-pressure acetylene generator, built in two sizes, having 50 and 100 pound carbide capacity respectively, replaces generators previously made by that company, while the generator having 300 pound carbide capacity is new. The three generators are suitable for supplying pressure-type or medium-pressure welding and cutting blowpipes.

In the generator, which has been redesigned, the feed mechanism has been changed to make the carbide shut-off more positive. A new method is used to stop the carbide feed positively in case the diaphragm breaks or zero pressure exists in the generator due to any other cause.

A new regulator of the stem type is used. The vertical pipe, leading downward to the back pressure valve and extending below the surface of the water, is fitted with an angle check valve. In case back pressure is exerted, water will be forced up the vertical pipe causing the check valve to close and preventing the possibility of back pressure or flash reaching the interior of the generator.

Two relief valves, one mounted on the hydraulic back pressure valve and the other direct-connected to the generator, are of new design and have larger capacity. A feature consists of interference levers which unseat the relief valves every time the generator is recharged. This arrangement automatically prevents the relief valves from sticking, should they be called upon to function for any cause.



NUMEROUS SAFETY FEATURES ARE INCLUDED IN THE DESIGN OF THE GENERATOR

The generator with 300 pounds carbide capacity is designed to supply gas with a minimum pressure fluctuation and with minimum maintenance expense. The feed is driven by a motor actuated by a weight. A diaphragm pressure control is used in connection with the motor to regulate the feed and maintain proper pressure in the generator. Two charging doors facilitate filling the hopper.

A clean-out door is provided which permits cleaning the carbide feed disk without removing the generator top. The filter may be repacked, if necessary, without breaking any adjustment of interference or relief valves. This operation is performed by removal of the top plate. The hydraulic back pressure valve is so arranged that it is always filled with water.

Grinding Wheel Makers Meet at Lenox

The annual meeting of the Grinding Wheel Manufacturers association of the United States and Canada was held at the Wyndhurst country club, Lenox, Mass., Sept. 28-29. At the business session Friday morning, Henry Duckworth, Norton Co., Worcester, Mass., occupied the chair.

The standardization committee, which includes George Chormann, Carborundum Co., Niagara Falls, N. Y., chairman, W. R. Moore, Norton Co., and L. E. Byers, Abrasive Co., Philadelphia, just has completed a thorough and comprehensive revision of the simplified practice bulletin, No. 45, giving standard sizes and shapes of grinding wheels. This bulletin is issued under the authority of the department of commerce.

Hold October Meeting

The October meeting of the New England Foundrymen's association was held at the Exchange club, Milk and Batterymarch streets, Boston, Oct. 10. The feature of the evening was the showing of a film entitled "Making Cast Iron Pipe" presented by a representative of the United States Cast Iron Pipe & Foundry Co., Burlington, N. J.

Addresses Foundrymen

J. W. Bolton, metallurgical engineer, The Lukenheimer Co., Cincinnati, addressed a joint meeting of the Newark Foundrymen's association and the American Society of Mechanical Engineers, metropolitan section which was held at the Down Town club, corner of Broad and Market streets, Newark, N. J., Oct. 24. Mr. Bolton had for his subject "Gray Iron: An Engineering Material."

To Visit Producers

The November meeting of the Detroit Foundrymen's association will be held Nov. 15. The meeting will be in the form of inspection trips to the Detroit coke ovens of the Semet-Solvay Co. and to the blast furnace of the Hanna Furnace Co.

Gains New Members

The Gray Iron institute, Terminal Tower building, Cleveland, has added to its membership roll the following firms: Detroit Gray Iron Foundry Co., Detroit; G & C Foundry Co., Sandusky, O.; Elizabeth Street Foundry Co., Chicago; Osborn Mfg. Co., Cleveland; Trumbull Mfg. Co., Warren, O.

What the Foundries Are Doing

Reflecting the Activities of the Gray Iron, Malleable, Steel and Brass Shops

Hull Steel Foundry Co., Hull, Que., will build an addition to its plant costing $250,000.

Riverside Foundry Co., Wrightsville, Pa., reports business good.

Lappen Foundry, Crookston, Minn., has started work on its addition, 60 x 120 feet.

Klein Iron Works, 65 Broadway, Astoria, N. Y., plans to build a 1 and 2-story plant and office building, 101 x 139 feet.

Great Western Stove Co., Leavenworth, Kans., contemplates an expansion program, intended to double its present production.

Illinois Foundry & Specialty Co., Morris, Ill., is planning to enlarge its plant. Charles Genzel is manager.

Modern Pattern Shop, 3409 East Ninety-third street, Cleveland, is inquiring for a 20-inch wood planer.

Mackintosh-Hemphill Co., Pittsburgh, plans the construction of a 2-story plant at Wooster, O.

Vollrath Co., Sheboygan, Wis., will build a 1-story addition, 150 x 160 feet, for manufacturing, storage and warehousing purposes.

Belle City Malleable Iron Co., Racine, Wis., has placed contracts with Nelson & Co., Milwaukee, for a 2-story power plant addition.

Los Angeles Foundry Co., 2444 South Alameda street, Los Angeles, is adding 6000 square feet to its present building.

Pittsburgh Foundry & Machine Co., Thirty-sixth street, Pittsburgh, has acquired property 48 x 460 feet for expansion of its plant.

J. Klein Iron Works, New York, has been incorporated with $150,000 capital by H. Koch, Long Island City, New York, attorney.

Fisher Brass Co., Delaware, O., has completed construction of an office building and has enlarged its plant at Marysville, O.

Zenith Foundry Co., 567 Seventy-fifth avenue, West Allis, Milwaukee, has broken ground for a foundry addition. (Noted Oct. 15.)

Campbell, Wyant & Cannon Foundry Co., Muskegon Heights, Mich., has plans for an expansion program including the erection of new buildings.

Royal Brass Mfg. Co., 1420 East Forty-third street, Cleveland, has awarded the contract for a manufacturing plant, 34 x 132 feet.

Frank Foundries Corp., Moline, Ill., is inquiring for new machinery and equipment for its 1-story foundry and shipping building 100 x 220 feet, now under construction.

Badger Foundry Co., Holborn and DeKoven avenues, Racine, Wis., is starting work on a coreroom addition, 70 x 70 feet, and is inquiring for core oven equipment.

Ouachita Iron Works, Inc., Monroe, La., is planning the construction of a new foundry, machine shop, forge and welding shops, and other units, at a cost of more than $60,000.

C. & G. Cooper Co., Mt. Vernon, O., has acquired the manufacturing end of the business of the Hope Engineering Co., Mt. Vernon.

Susquehanna Casting Co., Wrightsville, Pa., reports increasing business and that it has increased its working schedule from 4½ days to 6 days per week.

The plant of the Manufacturers Foundry Co., Holland, Mich., which was organized recently, is in operation and material and equipment are being purchased.

Nepperhan Foundry Co., Yonkers, N. Y., has been incorporated with $250,000 capital by J. Bowen, 81 Fulton street, Manhattan, attorney, to manufacture castings, etc.

United States Cast Iron Pipe & Foundry Co., Scottdale, Pa., on May 1, had reached 102 days without a lost-time accident with an average of 1100 employes.

National Cast Iron Pipe Co., Birmingham, Ala., has purchased the Alabama Cast Iron Pipe Co., Tarrant City, Ala., and will operate the plant at Tarrant City.

Conrad Foundry Co., Montgomery street, Elizabeth, N. J., has been sold to Ware & Leonard Foundry Co., which will operate the plant.

Stephen & Wolff Inc., Latham and Fulton streets, Rockford, Ill., has completed a 60-foot addition to its foundry building and will increase its space for machine shop quarters.

Stewart Bronze & Aluminum Foundry, Buffalo, has been incorporated by G. L. Grobe, Buffalo attorney, with 500 shares no par value stock.

Baker-Perkins Co. Inc., Saginaw, Mich., is inquiring for miscellaneous machinery and equipment for its 1-story foundry, 100 x 340 feet, to be built on Hess street. (Noted Oct. 15.)

Nash Motors Co., Kenosha, Wis., has let a contract to the Wisconsin Bridge & Iron Co., Milwaukee, for a second story, 20 x 780 feet and 40 x 118 feet, L-shaped, for its foundry at Kenosha.

Nichols & Shepard Co., Battle Creek, Mich., is inquiring for assembly equipment, traveling crane, etc., for its proposed 1-story threshing machine manufacturing plant, to be built on Marshall street.

Progressive Brass Mfg. Co., Tulsa, Okla., has changed its address from 917 East First street, to 1702-16 East Sixth street. It has moved its plant to larger quarters at the new address.

Maynard Electric Steel Casting Co., 1328 Twenty-second avenue, Milwaukee, has started work on the erection of a 1-story foundry addition, 100 x 121 feet. Frank J. Wabiszewski is secretary and general manager.

The plant of the Club Aluminum Utensil Co., Chicago, will be consolidated with the Baltimore plant and the local plant will be enlarged to provide additional manufacturing and storage space.

Ames Iron Works, Oswego, N. Y., a subsidiary of Pierce, Butler & Pierce Mfg. Co., New York, is increasing its manufacturing operations to include the production of a new type of highway roller.

Rome Electric Range Co., Huntsville, Ala., has awarded a general contract for the initial unit of its new 1-story plant, 50 x 250 feet. This unit will contain the foundry and machine shop.

Carroll Foundry & Machine Co., Bucyrus, O., which was purchased recently by Edward Purvis & Sons, Brooklyn, N. Y., has been sold to Charles F. Michael, president, Ohio Locomotive Crane Co., Bucyrus, O.

Manry Iron Works, Thomasville, Ga., has changed its name to the Manry Foundry & Machine Works. That company recently built a foundry addition to its plant which will be placed in operation soon.

A C Spark Plug Co., Dort highway, Flint, Mich., has awarded the general contract for its construction work including a heat treating building and a die casting building. (Noted Oct. 15.)

Chatfield Machine & Foundry Co., 718 Stephenson avenue, Escanaba, Mich., has been incorporated with $75,000 capital by Hubert H. Shepeck to engage in a general foundry and machine shop business.

Quality Alloy Casting Co., Easton, Pa., has been organized by T. A. Mellon and associates, 205 First National Bank building, to manufacture aluminum, brass, bronze and other metal castings. This company also will make hardware specialties.

Walworth Run Foundries Co., have awarded contracts to the Sam W. Emerson Co., Cleveland, for the building of its foundry, damaged by fire Sept. 16. The plant is located at 2500 West Twenty-fifth street. The contracts call for a structure costing $30,000.

United States Cast Iron Pipe & Foundry Co., Birmingham, Ala., is carrying out an expansion program at North Birmingham including a new unit for producing pipe 4 to 12 inches in diameter and 18 feet long.

Electric Steel & Mfg. Co., 3334 East Slauson avenue, Los Angeles, has awarded the contract for a plant addition, 60 x 130 feet. The company will also install a new annealing furnace, core baking oven and sand blasting equipment.

Chevrolet Motor Co., 3044 West Grand boulevard, Detroit, will re-equip and retool its foundry unit at Saginaw, Mich., and carry out other changes and improvements preparatory to starting production of new models.

Ohio Steel Foundry Co., Lagonda avenue and Gothic street, Springfield, O., is planning to build a three-story building, 60 x 150 feet, for pattern storage. The construction of a one-story building, 60 x 250 feet, to house the machine shop also is being considered.

Okaw Stove & Enameling Co., New Athens, Ill., has let the contract for the construction for the first unit of its plant. The building will house the enameling plant and will be 180 x 160 feet. A foundry will be built later that will be slightly larger than the enameling plant.

Delco-Remy Corp., Noble and Twenty-fifth streets, Anderson, Ind., is building a new foundry which will be completed about Nov. 15. The building is finished in brick and the interior is of steel and cement. One department has a decorative brick interior. Charles A. Nichols will be superintendent of the new foundry.

International Harvester Co., 606 Michigan avenue, Chicago, has asked bids on general contracts for a 1-story foundry, 160 x 320 feet, and a 2-story motor truck unit, 90 x 520 feet, at Rock Island, Ill. The project will cost more than $600,000 including equipment. W. D. Price is superintendent of construction.

Harrisburg Foundry & Machine Co. Inc., Harrisburg, Pa., has been incorporated and has taken over the business of the former Harrisburg Foundry & Machine Works. C. W. Lynch is president of the new company. He formerly owned and operated the plant, before selling his interest in 1920. The foundry and machine shops are well equipped and ready for operation.

Nordberg Mfg. Co., Milwaukee has bought the crusher business of the Symons Bros. Co., Chicago, and will consolidate it with its own plant at Milwaukee. The Symons company sells its patents, crusher business and goodwill. The engineering, sales and executive forces of this company are joining the Nordberg organization, which continues under its present management with Robert E. Friend as president. The Nordberg company will build additions to its plants at Chicago and Milwaukee.